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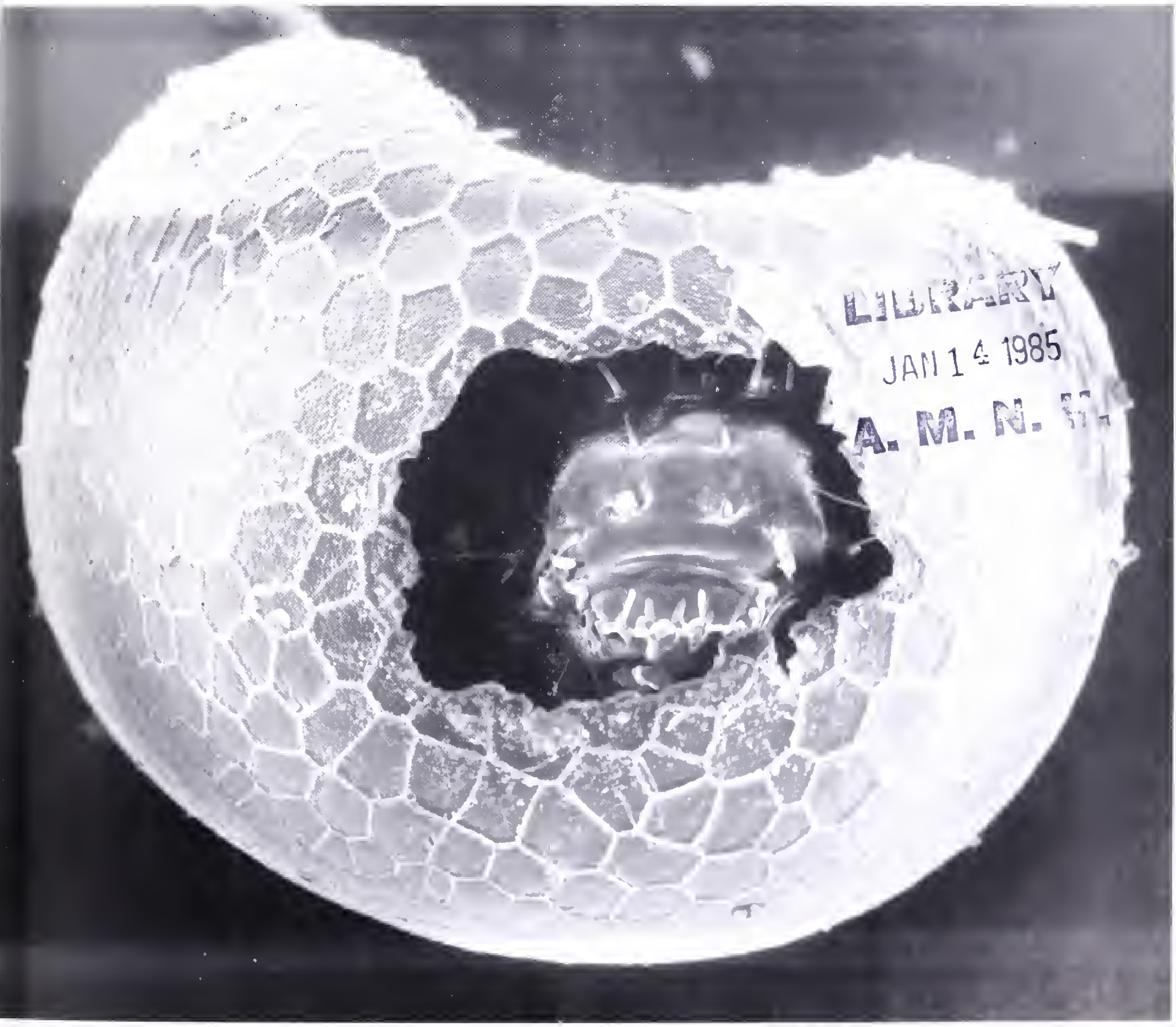
The ASB BULLETIN

Volume 33, Number 1 January 1986



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The Official Quarterly Publication of
The Association of Southeastern Biologists

ASB BULLETIN

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The ASB BULLETIN is the official quarterly publication of the Association of Southeastern Biologists, Inc., and is published at Lawrence, Kansas in January, April, July, and October. Letters and other contributions, as well as all communications about editorial matters, should be addressed to Dr. James W. Hardin, Department of Botany, North Carolina State University, Raleigh, NC 27695-7612. News items should be sent to the News Editor, Dr. Jon Fortman, Department of Biological Sciences, Mississippi University for Women, Columbus, MS 39701. Inquiries about missing numbers and other circulation matters should be addressed to Ms. Dorothy Hubbard, Circulation Manager, 2215 Hillthorpe Ave., Roslyn, PA 19001. Subscription orders from institutions should be sent to the Business Manager, Dr. R. L. Beckmann, Department of Botany, N.C. State University, Raleigh, NC 27695-7612. Subscription rate for non-members of the ASB: $12.00 per year. Printing and typography by Allen Press, Inc., Lawrence, KS.

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COVER

First instar larva of the **Grape Root Borer,** *Vitacea polistiformis* (Lepidoptera: Sesiidae), eclosing from its egg. These larvae feed on roots of grape (*Vitis* spp.) in eastern North America and can be a problem in commercial vineyards. Actual egg diameter .75 mm. Scanning electron micrograph taken by S. Bambara and J. Burnette, Dept. of Entomology, North Carolina State University, Raleigh.

TIME AND PLACE OF FUTURE MEETINGS

1986	April 9–12	University of South Carolina, Columbia
1987		University of Georgia, Athens (50th Anniversary)

PATRON MEMBERS

Carolina Biological Supply Co., Burlington, NC
Martin Microscope Company, Easley, SC

About the Columbia Meeting

The University of South Carolina will host the 47th Annual Meeting of the Association of Southeastern Biologists on April 9–12, 1986. Registration will take place at the Carolina Inn, the host motel and meeting headquarters, and at the Russell House on the U.S.C. campus. The paper and poster sessions, exhibits, placement services, and the general session will also be in the Russell House. A garden party either at the restored Lace House and Boylston Garden or at the antebellum Robert Mills House and Garden Thursday evening will feature pit-cooked barbeque, first introduced from southern Germany and now a tradition for the Midlands of South Carolina. This event, centered in the historical section of the city, will include music by a Jazz Ensemble and a special program by Carolina Alive, a student chorus famous for its entertainment of Kings and Queens. After a social hour on Friday evening, the traditional banquet will be held in the Columbia Ballroom of the Carolina Inn.

SOCIETIES MEETING WITH ASB IN COLUMBIA

American Society of Ichthyologists and Herpetologists, Southeastern Division
Beta Beta Beta, Southeastern Region
Botanical Society of America, Southeastern Section
Ecological Society of America, Southeastern Chapter
Southeastern Fishes Council
Southern Appalachian Botanical Club

COLUMBIA AND THE UNIVERSITY OF SOUTH CAROLINA

Columbia, the capital of South Carolina, is located at the geographical center of the state where the Saluda and Broad Rivers meet to form the Congaree. The metropolitan area of the city contains over 400,000 people and features the nationally recognized Riverbanks Zoo, an art museum, several active theater groups, and many important historical sites. Columbia will be celebrating its Bicentennial in 1986, and its historical landmarks include beautiful antebellum homes and stately public buildings. It numbers among the fastest-growing Southern cities. Almost overnight, it is transforming its 19th-century parks, mills, waterworks, and railroad into 21st-century assets that will delight visitors and residents alike with their scenie beauty.

Founded in 1801 as South Carolina College, the University of South Carolina is the oldest state institution in the United States to be continuously supported by public funds. From the original campus just blocks away from the South Carolina State House, the University has grown to a system of nine campuses located throughout the state. The institution currently enrolls nearly 35,000 students system-wide. Undergraduate enrollment of the Columbia campus in the fall of 1985 was 15,089 (an almost 50-50 ratio of men to women) with a graduate enrollment of 8,174. Eighty percent of the student body is from South Carolina, but students come to USC from all other states and from 100 foreign countries. Minorities make up about 14 percent of the student body. The University's instructional programs are administered through 17 units, and sixty-two programs of study are offered leading to the bachelor's degree. The master's degree is awarded in 104 fields and the doctorate in 50. The library collections contain more than two million volumes, 2.3 million microfilms, 2.4 million manuscripts, and about 17,000 current periodicals. Thomas Cooper Library, the main library facility, is ranked as one of the nation's top 50 research libraries.

The Department of Biology was established in 1906 and awarded its first master's degree in 1923. The Ph.D. program was initiated in 1953, and graduate enrollment has risen to about 75 students from many states and a number of foreign countries. With a faculty of 38 teaching and research professors, the department provides the expertise, the modern facilities, and the flexible curriculum needed to train students in many fields of biology. Currently there are approximately 500 undergraduate majors in pursuit of the B.S. degree. The graduate programs provide training in six principal areas: Botany, Developmental Biology, Ecology, Genetics, Molecular and Cell Biology, and Zoology. Eleven biology professors hold joint appointments in the University's Marine Science program. In addition, the M.A.T. degree in Biology is offered, in cooperation with the College of Education, for students whose primary goal is to teach biology.

PRE-REGISTRATION AND REGISTRATION

A PRE-RESGISTRATION form is provided with this copy of the bulletin. Your pre-registration will enable us to better plan facilities and services to be expected at the ASB meeting. Pre-registration packets and late registration will be at the Carolina Inn on Wednesday from 5–10 P.M. and at the USC Russell House on Thursday & Friday (see general schedule). Early pre-registration will not only aid us, but will assure your reservation for field trips, special meals, and social events. Only a limited number of tickets for special events will be available at the registration desk.

Please bring your April 1986 **ASB Bulletin** to the meeting. No free copies will be available at USC. However, copies will be available at $3.00 each.

TRAVEL TO COLUMBIA AND THE UNIVERSITY OF SOUTH CAROLINA

Automobile—Columbia, SC is easily accessible by interstate highways, being located at the intersection of I-20, I-26, and I-77 and is approximately 50 miles west of I-95 and 100 miles south of I-85. Consult the maps to be published in the April 1986 **ASB Bulletin** for details.

Bus Service—Columbia is served by both Greyhound and Continental Trailways. The terminals of both of these bus lines are reasonably close to the USC campus.

Train—Columbia is located on a major North-South route of the Amtrak System.

Air Service—Six major airlines serve Columbia—American, Delta, Eastern, Piedmont, People's, and United. There are also several commuter-type airlines available. The airport is approximately 10 miles to the west of downtown Columbia. Transportation from the airport is available in the form of taxi, limo service, and buses until 6:00 P.M. Possibly a shuttle will be available also. Rental cars are also available from several operators. Hertz Rent-A-Car is offering a discount to ASB members. More information on this is available from Hertz (1-800-654-2240); refer to the ASB Meeting.

Parking—As on most campuses, parking is limited. For those staying in motels near campus we suggest that you park at the motel and walk to the meetings. A large city parking lot (50¢/day) is located on the corner of Greene and Park Streets, within walking distance. USC has an on-campus shuttle service which stops near this lot.

ACCOMMODATIONS

Housing will not be available on campus because the semester will be in regular session. A large number of hotels and motels in the area can accommodate our housing needs. Meeting headquarters, and closest accommodations to the campus, will be at the Carolina Inn (937 Assembly Street, zip 29202). Several places provide special rates for ASB participants or commercial rates for University of South Carolina activities. Be sure to inquire about getting such rates when you make your reservations directly with them. Also be advised that our meeting coincides with the Masters Golf Tournament held in Augusta, Georgia—motels in Columbia are usually full for the duration of the tournament, **so make your reservations early!** (Carolina Inn guarantees the flat rate only through **March 9.** Indicate number of people for your room.)

Carolina Inn (Meeting Headquarters) (803) 799-8200 937 Assembly Street (2 blocks away from campus)	$52 flat rate per room, 1–4 occupancy; 240 rooms
Columbia Marriott Hotel (803) 771-7000 1-800-228-9290 1200 Hampton Street (8 blocks away)	S: $72 D: $84 300 rooms
Comfort Inn, Uptown (803) 252-6321 1-800-228-5150 2025 Main Street (5 minute drive)	S: $45 D: $51 + $3/person/room 117 rooms
Governor's House (803) 779-7790 1301 Main Street (4 blocks away)	S: $45 D: $51 101 rooms
Heart of Columbia (803) 799–1140 1011 Assembly Street (3 blocks away)	S: $25 D: $28 171 rooms
Holiday Inn, City Ctr. (803) 799-7800 1-800-HOLIDAY 630 Assembly Street (3 blocks away)	S: $39 D: $46 171 rooms
Matador Motor Inn (803) 772-4910 1444 Bush River Road (15 minute drive)	S: $30 D: $36 125 rooms
Ramada Inn (803) 796-2700 1-800-228-2828 I-26 & U.S. 378, West Columbia (15 minute drive)	S: $46 D: $54 120 rooms
Red Carpet Inn (803) 796-6550 1-800-251-1962 505 Knox Abbott Drive, Cayce (5 minute drive)	S: $25 D: $30 110 rooms
Red Roof Inn (803) 798-9220 1-800-848-7878 10 Berryhill Road (10 minute drive)	S: $25 D: $32 109 rooms

Rodeway Inn (803) 796-6030 1-800-228-2000 Knox Abbott Drive, Cayce (5 minute drive)	S: $28 D: $30 76 rooms
Sheraton Columbia NW (803) 731-0300 I-20 & Bush River Road (10 minute drive)	S: $50 D: $58 100 rooms
St. James Capital Inn (803) 252-3100 1901 Assembly Street (5 minute drive)	S: $26 D: $33 100 rooms
The Town House (803) 771-8711 1615 Gervais Street (4 blocks away)	$45 flat rate per room + $8/ person for more than 2 per room
Tremont Motor Inn (803) 796-6240 111 Knox Abbott Drive, Cayce (5 minute drive)	S: $29 D: $33 100 rooms

CAMPING FACILITIES

The nearest camping facilities are about 15 miles from campus in Sesquicentennial State Park, 9564-D Two Notch Road, Columbia, SC 29223. Call (803) 788-2706 or 788-0437 for reservations. There are 87 campsites with electricity and water plus shower facilities. Costs are very modest, depending on whether you pitch a tent or have a large RV.

GENERAL SCHEDULE

Wednesday

Registration: 5:00–10:00 P.M., Carolina Inn
Social Mixer with cash bar: 6:00–9:00 P.M., Mezzanine, Carolina Inn
Executive Committee Meeting: 7:00 P.M., Carolina Inn
Field Trips: Begin at 9:00 A.M. and 1:30 P.M., see description of Field Trips and Pre-registration form

Thursday

Registration: 7:30 A.M.–5:00 P.M., Russell House
Past President's Breakfast: 7:00 A.M., Faculty House
Paper and poster sessions, placement service: Russell House
General Plenary Session: 8:30–9:45 A.M., Law School Auditorium
"***Air Pollution Effects on Southeastern Forests: Current Status.***" Presented by *Dr. Ellis B. Cowling,* Professor of Plant Pathology and Assoc. Dean, School of Forest Resources, North Carolina State University, Raleigh, NC
Exhibits: 8:00–5:00 P.M., Russell House
Symposium: 1:00–4:00 P.M., Russell House
Blackwater River Ecosystems. Co-sponsored by the Southeastern Chapter of the Ecological Society of America and ASB. Organized by Courtney Hackney
Business Meeting: Southeastern Chapter of the Ecological Society of America, 4:00–5:00 P.M.
Forum for Herbarium Curators and Users in the Southeast: 4:00–5:00 P.M.
Garden Party at the Lace House and Boylston Garden or at the Robert Mills House and Garden: 6:00–9:00 P.M., see Pre-registration form

Friday

Breakfast and business meeting: Southern Appalachian Botanical Club (50th

Anniversary) and Southeastern Section, Botanical Society of America, 7:00–9:30 A.M., Carolina Inn
Business meeting: Southeastern Division of the American Society of Ichthyologists and Herpetologists, 8:00–9:00 A.M., Russell House Theater
Business meeting: Southeastern Fishes Council, 9:00–10:00 A.M., Russell House Theater.
Late registration: 8:00 A.M.–12:00 Noon, Russell House
Paper and poster sessions, placement service: Russell House
Exhibits: 8:00 A.M.–5:00 P.M., Ballroom, Russell House
ASB Business Meeting: 11:15 A.M.–12:15 P.M., Russell House Theater
Beta Beta Beta Luncheon: 11:45 A.M.–1:15 P.M., Carolina Inn
Southeastern Chapter of the Ecological Society of America Luncheon: 12:30–2:00 P.M., Carolina Inn
Symposium: 2:15–5:15 P.M., Russell House
Barrier Islands. Cosponsored by the Southeastern Chapter of the Ecological Society of America and ASB. Organized by Courtney Hackney
Social Hour with cash bar: 6:00–7:00 P.M., Carolina Inn
ASB Banquet: 7:00 P.M., Carolina Inn

Saturday
Executive Committee Meeting: 8:00 A.M., Carolina Inn
Field Trips: Begin at 8:00 A.M.. Departures from parking lot of Carolina Inn

POINTS OF INTEREST IN THE COLUMBIA AREA

COLUMBIA RIVERFRONT PARK—Contact: The City of Columbia Parks & Recreation Dept. 733-8331.

GIBBES PLANETARIUM—1112 Bull Street. Contact: Mark Tucker (799-2810) Admission: $1.50 for adults, $1.00 for students. Open only for pre-arranged groups M–F. Open to the public week-ends. Exhibits include "Sky Over Columbia" and seasonal presentations.

GOVERNOR'S MANSION—800 Richland Street. Contact: Joan Davis (758-3452). Tours by appointment only. Built in 1855, the Mansion has been the residence of South Carolina's "First Families" since 1868.

HAMPTON-PRESTON MANSION—1615 Blanding Street. Contact: Linda Morgan (252-7742). Admission: $1.50 ($1.00 for groups of 10 or more). Built in 1818, the home has been beautifully restored and furnished in the style of the years 1835–1855.

LAKE MURRAY COUNTRY—Contact: Miriam Silver (731-9990). A 50,000-acre lake, with more than 500 miles of shoreline, Lake Murray is a haven for watersports enthusiasts of all kinds. The lake is located 15 miles from downtown Columbia.

RIVERBANKS ZOO—500 Wildlife Parkway. Contact: Mary Leverette (779-8717). Admission: $3.25 for adults, $1.25 for students. Group rates $1.75 for adults, $0.75 for students. Over 700 animals in the Riverbanks Zoo collection are housed in natural habitat exhibits utilizing psychological barriers, such as moats, water, and light, to create an environment free of bars and cages for both visitor and animal. The nationally famous award-winning zoo has recently been listed in the top 10 zoos in the United States.

ROBERT B. MILLS HOUSE & PARK—1616 Blanding Street. Contact: Linda Morgan (252-7742). Admission: $2.00 ($1.50 for groups of 10 or more). Beautifully restored house and gardens, built in 1823 by Robert B. Mills.

MANN-SIMONS COTTAGE—1403 Richland Street. Contact: 252-1450. Tours by appointment only. Admission: $1.00 for groups of 10 or more. Built in 1850 by Celia Mann, one of only 200 free blacks in Columbia. The cottage has been restored to its 1880 appearance.

MOVIETONE NEWS EXHIBIT—University of South Carolina McKissick Museum. Contact: Catherine Horne (777-7251). Admission: Free. Complete collection of Movietone News film shown continuously; special showings can be arranged.

SOUTH CAROLINA STATE HOUSE—Main at Gervais Street. Contact: Andrena Davis (758-2477). Admission: Free. Construction of State House began in 1851 and was completed (after surviving Civil War attack) in the early 1900's.

WOODROW WILSON BOYHOOD HOME—1705 Hampton Street. Contact: Linda Morgan (252-7742). Admission: $1.50 ($1.00 for groups of 10 or more). Designed and built by Wilson's parents in 1872, the home has been restored and furnished with Wilson family pieces.

MUSEUMS

COLUMBIA MUSEUM OF ARTS AND SCIENCES—1112 Bull Street. Contact: Mark Tucker (799-2810). Admission: Free. Group tours: arranged in advance, 50¢ per person. Permanent art collection as well as changing exhibitions in three galleries.

CONFEDERATE RELIC ROOM & MUSEUM—Sumter at Pendleton Street. Contact: Lee Mangum (758-2144). Admission: Free. Relic collection from Colonial Period up to Vietnam War era.

FORT JACKSON MUSEUM—Jackson Boulevard. Contact: 751-7419. Admission: Free. Located on the Ft. Jackson post, the museum covers over 200 years of the American soldier.

LEXINGTON COUNTY MUSEUM—Fox Street, Lexington, SC. Contact: 356-8369. Three 18th-century cabins, two antebellum homes, 1870 Post House, and the 1832 John Fox House.

MCKISSICK MUSEUMS—University of South Carolina. Horseshoe. Contact: Maria Ballard (777-7251). Admission: Free. Includes art exhibits, geological display, University archives, and many special exhibits.

SOUTH CAROLINA CRIMINAL JUSTICE HALL OF FAME—5400 Broad River Road. Contact: 758-6101. Admission: Free. Exhibits on the historical and contemporary aspects of law enforcement. Special student's programs. Reservations must be made in advance.

SOUTH CAROLINA STATE ARCHIVES—1430 Senate Street. Contact: 758-5816. Admission: Free. Restores and houses important documents of historical significance to South Carolina. Includes many temporary, special exhibits.

VISITOR'S CENTER

GREATER COLUMBIA VISITOR'S CENTER—1527 Senate Street, Columbia, South Carolina 29201. Contact: (803) 254-0479. Visitor's information available for hotels, restaurants, activities, cultural events, and tours.

TOURS

HISTORIC COLUMBIA FOUNDATION TOURS—1616 Blanding Street. Contact: Linda Morgan (252-7742). Bus tours, historic homes tours, etc. Rates vary.

STATE HOUSE TOURS—Main at Gervais Street. Contact: Andrena Davis (758-2477). Free tours of State House given every half-hour, weekdays.

FIELD TRIPS

Field trips this year commemorate the 50th Anniversary of the Southern Appalachian Botanical Club and are also co-sponsored by the Southeastern Section of the Botanical Society of America and by the Southeastern Chapter of the Ecological Society of America. Unless otherwise noted, all field trips will leave from the Carolina Inn—the cost of the trip includes transportation and/or lunch. Please pre-register because space will be limited. If use of your own vehicle is preferred, please check with the field trip desk at the time of registration.

Wednesday, 9 April 1986

1. **Savannah River Ecology Laboratory (SREL) and Savannah River Plant (SRP)** (9:00 A.M.–4:00 P.M.)—Ecological research programs at SREL will be reviewed and field sites on SRP will be visited. Emphasis will be given to studies of floodplain and swamp wetlands, Carolina bays, and thermally affected streams and reservoirs, to long-term research on plant and animal populations, and to studies of responses of southeastern ecosystems to disturbance. The trip will *meet at SREL,* near Aiken, SC. All participants must be U.S. citizens and we must have your *full* name (no initials) for security clearance. Maps and motel information available upon request. Pre-registration *must be received no later than March 17th. Led by Dr. Rebecca Sharitz and Dr. J. Whitfield Gibbons.*
2. **Conagree Swamp National Monument** (1:30 P.M.–5:00 P.M.)—The most striking feature of this extensive tract of virgin bottomland hardwood forest and cypress-gum swamp is the enormous size of the trees—8 national and 18 state record-sized trees occur here. With an overcup oak measuring 22 feet in circumference, a laurel oak measuring almost 21 feet, and a loblolly pine over 15 feet, this is indeed the "Forest of Champions." *Led by Dr. Wade T. Batson.*

Saturday, 12 April 1986

3. **Stevens Creek Natural Area and Savannah River Bluffs** (8:00 A.M.–5:00 P.M.)—The circumneutral soils of the steep north-facing bluffs of Stevens Creek

Natural Area harbor a high diversity of herbaceous species and numerous rare or unusual plant species in a relict mixed mesophytic forest. This area is a major Pleistocene refugium and has been designated as a National Natural Landmark. In addition to the rare zig-zag salamander, of special interest is the presence of *Ribes echinellum,* known from only two populations in the world. The nearby Savannah River Bluffs also contain a high diversity of rare and disjunct species including *Aesculus parviflora, Trillium reliquum,* and *Cladrastis kentukea. Led by Dr. Albert E. Radford.*

4. **Peachtree Rock and Shealy's Pond Preserves** (8:00 A.M.–3:00 P.M.)—Peachtree Rock Preserve contains the largest assemblage of sandstone outcrops in the state. Of interest are representative examples of longleaf pine-turkey oak scrub, mountain laurel-*Galax,* and sand myrtle-mountain laurel communities, as well as several rare sandhill species. Shealy's Pond consists of seepage slopes and related habitats along an old mill pond in the fall-line sandhills. Excellent examples of white-cedar shrub bog, sphagnum bog, pond margin and stream channel communities are present. Species of interest include three species and one hybrid of *Sarracenia, Gaylussacia mosieri,* and *Vaccinium sempervirens,* endemic to Lexington County, SC. *Led by Dr. Douglas A. Rayner.*
5. **Flat Creek Natural Area and Forty Acre Rock** (8:00 A.M.–5:00 P.M.)—This area, a National Natural Landmark, contains the most significant assemblage of granitic flatrock outcrops in South Carolina and the largest diabase dike in North America. Excellent examples of all flatrock communities are present. *Amphianthus pusillus, Draba aprica,* and *Sedum pusillum* are the most significant of the numerous flatrock endemics found here. The herbaceous flora of the mesic hardwood forest associated with the diabase dike is particularly rich and diverse. *Led by Dr. James F. Matthews.*

LOCAL ARRANGEMENTS COMMITTEE

Co-chairmen:	John M. Herr, Jr.	(803) 777-8110
	David H. Rembert, Jr.	-3837
Program:	Wallace D. Dawson	-3107
	David E. Lincoln	-7306
Pre-registration and Registration:	Gerald T. Cowley	-3167
Audio-visual:	David L. Claybrook	-3163
Exhibits and Exhibitors:	B. Theodore Cole	-6091
	Richard G. Zingmark	-4873
Field Trips:	Cynthia A. Aulbach-Smith	-8196
Social Activities:	David D. Husband	-4255
Transportation and Parking:	E. Fontelle Thompson, Jr.	-5153
Accommodations:	Robert J. Feller	-3937
Host Motel and Meeting Headquarters:	Carolina Inn 937 Assembly Street Columbia, SC 29202	(803) 799-8200

ASB PRE-REGISTRATION FORM

University of South Carolina Meeting

(Type or print; one form for each registrant please)
(Duplicate as needed)

NAME ____
DEPT. ____________________ SCHOOL ____________________
CITY ________________________ STATE ________ ZIP CODE ________

If you have made housing reservations please provide below the name of the hotel, motel, or housing address for the meeting directory.

____

____

PLACE A CHECK MARK IN THE APPROPRIATE BLANKS.

PRE-REGISTRATION

Regular $10.00 _____ Student $6.00 _____
(Registration at the meeting will be: Regular $12.00; Student $8.00).

MEALS

ASB BANQUET
Regular .... $12.00 _____
Student .... $10.00 _____
Garden Party Barbeque in
HistoricalColumbia
(Thursday evening 6–9 P.M.) . . $11.00 _____
BETA BETA BETA
Luncheon .... $6.00 _____

SE Chapter, Ecological Society of
America Luncheon .... $8.00 _____
Southern Appalachian Botanical Club/
SE Section, Botanical Society
of America Breakfast .... $7.25 _____

FIELD TRIPS

Wednesday No. 1 .... $5.00 _____
No. 2 .... $2.00 _____

Saturday No. 3 .... $10.00 _____
No. 4 .... $6.00 _____
No. 5 .... $10.00 _____

Make check for total amount payable to ASB Local Committee. Send a completed copy of this form and your check by *April 1* to:

University of South Carolina
Pre-registration
% G. T. Cowley
Department of Biology
University of South Carolina
Columbia, SC 29208.

Association Affairs

Guidelines for Poster Sessions

Poster sessions have been incorporated as a regular means of scientific presentation at the annual ASB meetings. This type of presentation will afford a more informal environment that encourages a direct interchange of ideas and discussion between presenter and audience. Adherence to the following guidelines will help ensure the effectiveness of the poster sessions.

Poster sessions will be held in the Student Union in an area adjacent to other meeting rooms. The specific time and location will be published in the April program issue of the **ASB Bulletin.** Posters will be organized by subject matter and numbered sequentially in accord with abstract listings in the **ASB Bulletin.** All posters will be on display for a half day, although authors or co-authors are required to be with their poster papers only during a specified two-hour period. Thumb tacks and tape will be provided. Backing paper or other special display materials should be supplied by each presenter.

Posters should be carefully planned to maximize clarity and simplicity in conveying information. Poster boards of approximately 4′ by 4′ will be available for each paper. Arrange for a heading including title, author(s) and institution to be placed at the top in letters no less than 3 cm high. The body of the poster should include figures, tables, graphs, maps, or photographs displayed in a well-organized and coherent sequence from top to bottom. Do not crowd the display. All materials including text, legends, and captions on figures or tables should be legible from a distance of about 2 m. Each illustration should be captioned. A limited degree of text (letters at least 1 cm high) can be included, but care should be taken not to overwhelm the audience. Authors may choose to post a large typeset copy of the abstract at the top of the poster and include a clear listing of specific conclusions at the bottom.

GUIDELINES FOR RESEARCH AWARDS

The Faculty Research Award—$500 given by ASB. Three copies of the paper, written in a style and format appropriate for publication in a refereed journal, should be sent to Dr. M. R. Willig, Biology Department, Texas Technological University, Lubbock, TX 79416. The deadline is February 1, 1986. See Call-for-Papers and **ASB Bull**. 32: 122–123 for details.

The Student Research Award—$500 given by Martin Microscope Company. The guidelines are the same as for the Faculty Award except the person presenting the paper must be a student at the time of presentation. Three copies should be sent, by February 1, to Dr. Richard L. Buckner, Department of Natural Science and Math, Livingston University, Livingston, AL 35470. See Call-for-Papers and **ASB Bull**. 32: 123 for additional information.

The Eugene P. Odum Award—$100 and a plaque given by the Southeastern

Chapter of the Ecological Society of America, for the best ecological paper presented by a student.

The paper will be evaluated by a panel of judges at the time of presentation on the following points: (a) Significance of Ideas; (b) Creativity; (c) Quality of Methodology; (d) Validity of Results; (e) Clarity of Presentation.

Eligibility Requirements:

(a) Undergraduate and graduate students are eligible;
(b) The student must be the sole or senior author;
(c) The paper must deal with a clearly ecological topic and should be presented in any of the following sessions: Aquatic Ecology, Plant Ecology, or Animal Ecology;
(d) The paper must be presented in a regular contributed session; papers presented in poster sessions or symposia are ineligible;
(e) The student does not have to be a member of SE/ESA;
(f) The title and abstract of the paper must be submitted to the Award Coordinator by February 1. This can be a copy of the abstract submitted to ASB November 1. Submit to: Dr. T. R. Wentworth, Dept. of Botany, N.C. State University, Raleigh, NC 27695-7612.

The North Carolina Botanical Garden Award—$100 given by NCBG (through the Southeastern Section of the Botanical Society of America and the Southern Appalachian Botanieal Club). This is given for an especially meritorious paper presented in the areas of plant systematics, evolution, or conservation. The paper will be evaluated by a panel of judges at the time of presentation, on the following points: (a) significance of ideas, (b) creativity, (c) quality of methodology, (d) validity of results, and (e) clarity of presentation. The actual prize will be presented at the ASB Banquet.

Eligibility Requirements:

(a) All individuals eligible to present a paper at the ASB meetings are eligible for this award.
(b) The paper must deal with the systematics, evolution, species biology (including population biology), or conservation of vascular plants that are native or naturalized to the southeastern United States.
(c) The paper must be presented in a regular Plant Systematics contributed-paper session; papers presented in poster sessions or in symposia are not eligible.
(d) The title and abstract of the paper must be submitted to the Award Coordinator by February 1, 1986. This may be a copy of the abstract submitted to ASB November 1. Individuals interested in entering a paper for this award should submit the title and abstract to: Dr. George Ramseur, Dept. of Biology, University of the South, Sewanee, TN 37375.

ASB ENRICHMENT FUND

The *ad hoc* committee on Endowments, Dr. W. C. Grant, Chr., recommends the following addition to the Bylaws. It will be voted upon at the business meeting to be held on April 11, 1986.

ARTICLE IX. Association of Southeastern Biologists Enrichment Fund

Section 1. The Association of Southeastern Biologists (ASB) shall establish and maintain, pursuant to the terms and conditions outlined below, an Association of Southeastern Biologists Enrichment Fund to support educational activities of the ASB. The Association of Southeastern Biologists Enrichment Fund shall support several types of educational activities including the following:

A. Scholarship awards to graduate and/or undergraduate students;
B. Externships and summer research opportunities for undergraduate and/or graduate students;
C. Research prizes for especially meritorious papers presented at the Annual Meeting by students and by senior scientists;
D. Awards to encourage excellence in graduate research and teaching;
E. Meritorious Teaching Award for an outstanding contribution to biology, especially in service to young people;
F. Travel awards to assist graduate students with expenses at the annual ASB meeting;
G. A biology lecture series;
H. Other educational activities of the ASB.

Section 2. Association of Southeastern Biologists Enrichment Fund shall be managed by a Board of Trustees which shall be responsible for the prudent investment of all endowment funds of the ASB. The Board shall consist of five (5) members appointed by the Executive Committee, and the Treasurer as an ex officio member. Three (3) of the Board members shall be appointed for a term of four (4) years each and two (2) Board members shall be appointed for a term of three (3) years each. Each year, the board shall elect one of its members to serve as Chairperson. The Chairperson shall be eligible for re-election. Board members shall be eligible for reappointment to one (1) additional term on expiration of their term. The Board of Trustees shall report their actions to the ASB at the Annual Meeting. No board member shall receive compensation from the Fund.

Section 3. The Board of Trustees shall receive and administer, as part of the Association of Southeastern Biologists Enrichment Fund, bequests and any other kind of property that may come to them from any source. The Board shall have the power to buy, sell, exchange, lease, transfer, or otherwise dispose of any property, real or personal, with respect to the Fund. Bequests and gifts received for specific purposes shall be administered in accordance with the wishes of the donors. Those bequests and gifts without specific designations shall be added to the General Fund of the Association of Southeastern Biologists Enrichment Fund, described in Section 4.

Section 4. Contributions to the Association of Southeastern Biologists Enrichment Fund shall be received in three categories as follows:

A. General Fund—Contributions and annual earned income shall be available each year to meet educational activities and objectives as listed in Section 1.
B. Restricted Funds—These are funds given to meet a specific educational activity and/or objective for a period of one or more years.
C. Endowments—Endowments are established to provide long-term support to meet specific educational objectives and activities with only the annual earnings of each endowment expended to meet the objectives for which each was established.

Named Endowments may be established in honor, or in memory, of a distinguished colleague or family member.

Endowments may be established to meet educational activities and objectives as listed in Section 1 and others approved by the Board of Trustees.

Section 5. Income Allocation—The General Fund, Restricted Funds, and Endowments shall be allocated income based on the average balance of each Fund's participation of the total amount invested for the Association of Southeastern Biologists Enrichment Fund for each fiscal year.

Section 6. Investment Policy—In order to protect the funds contributed and entrusted to the trustees of the Association of Southeastern Biologists Enrichment Fund by donors to meet short and long-range objectives, funds shall be invested in government agency securities offering the highest interest rate at the time of purchase. Since changes in the economy and other factors greatly affect interest rates and earnings on securities, funds shall be invested in securities up to a period of five years unless otherwise approved by the Board of Trustees.

Section 7. An audit of the Association of Southeastern Biologists Enrichment Fund shall be made at the close of each fiscal year by the ASB Auditing Committee. The auditor's report shall be presented to the Association of Southeastern Biologists at each annual meeting.

The present Article IX (Amendments) will be changed to Article X, upon approval of the above new article.

NEW BULLETIN DEADLINES

Those sending material for publication in the **ASB Bulletin** should note the following deadlines for receipt by the Editor.

January issue—October 10
April issue—December 1
July issue—May 1
October issue—July 10

Book Reviews

Westman, W. W. 1985. **Ecology, Impact Assessment, and Environmental Planning.** John Wiley & Sons, Inc., New York, NY 10022. $65.00. 532 pp., illus., hardback.

This book is intended as a text for upper division undergraduate, graduate, and professional courses in impact assessment, applied ecology, environmental planning, and related subjects and as a reference for environmental consultants, resource managers, planners, and decision makers. Westman draws from a wealth of literature (about 1200 citations, two-thirds of which were published in the last decade), which he analyzes from the perspective of an academic with primarily ecological training. He begins with a thorough discussion of the progress of ecological impact assessment, correctly stressing its iterative nature, the need to consider alternatives, and the importance of feedback mechanisms. He next presents an unfortunately too-brief and frequently erroneous primer on environmental law—by far the weakest part of the book—and continues with a detailed account of processes and procedures in environmental decision making—complementary to the earlier outline of impact assessment. The remaining sections deal with summarizing, evaluating, and predicting physical and biological impacts. Here the organization gets a bit cloudy. The presentation is basically a review and analysis of methodology reported in the literature, and much methodology doesn't fit a clean use taxonomy. Soil capability classes (pp. 202–205) appear more useful in evaluating impacts than in predicting them, yet this discussion appears within *Predicting Impacts.* All economic approaches (pp. 168–194) are covered under *Evaluation,* yet most have predictive value (some might argue this point). Checklists and matrices (pp. 131–138) appear in *Summarizing and Evaluating,* whereas their greatest value may be as screening mechanisms. These are minor deficiencies. They illustrate more the difficulty inherent in organizing this kind of material than shortcomings of the author—but they detract from continuity and cause the reader to ask "Where am I?" The last section *Predicting Impacts: The Biota* is an excellent review of current methods to sample, analyze, and describe ecosystems and their components. It contains an in-depth discussion of problems related to spatial and temporal distributions (pp. 409–439); reflects popular concern for diversity (pp. 444–475); and properly stresses the importance of succession, inertia, and resilience in considering the effects of environmental changes (pp. 480–516). Old-time ecologists may be disappointed to discover, however, that the excellent discussion of guilds contains no mention of niches and that indicator organisms are presented without reference to the *concepts* of limiting factors, tolerance, and thresholds. Predictive modellers (particularly those involved in habitat evaluations) may feel that their interests deserve more attention. Those seeking a manual of cookbook instructions surely will be disappointed, for Westman never says "This is the way." But he does what he set out to do—he reviews a great mass of current and relevant literature; he presents the pros and cons of each concept presented; he directs the reader to sources of additional information; and he does so in an interesting and readable manner. Thus he has created the reference document he intended. As presented, the material can readily serve as a basis for discussion-oriented *advanced level* courses, but is not the kind of text that lends itself to section-by-section, chapter-by-chapter presentation without explanation or amplification. *(David A. Adams, Forestry Department, North Carolina State University, Raleigh, NC.)*

Genetic Engineering: A Natural Science. Monsanto Company, St. Louis, MO 63167. 21 pp., paperback. Free.

This little informational booklet is intended to help explain the terminology and facts about genetic engineering and its realistic applications to agriculture, animal health and nutrition, human health care, chemical production, and waste management. It is well illustrated and would serve as a fine introduction of the topic to undergraduates. It may be obtained from Direct Mail Corp. of America, 1533 Washington Ave., St. Louis, MO 63103. The booklet was prepared to accompany a 17-minute documentary film entitled **"Genetic Engineering: The Nature of Change,"** which is part of a public service program aimed at helping to increase public understanding of this important technology. Filmed on location across the U.S., the sound and color film incorporates interviews with leading scientists and physicians working in genetic engineering. The film introduces the basic concepts and explains its applications. Available on free loan (in 16 mm film, ¾ in videotape, or ½ in videotape) from Modern Talking Picture Service, Inc., Film Scheduling Center, 5000 Park St. N., St. Petersburg, FL 33709. *(Ed.)*

News of Biology in the Southeast

Jon R. Fortman—*News Editor*
Division of Science and Mathematics
Mississippi University for Women
Columbus, Mississippi 39701

ABOUT PEOPLE AND PLACES

Alabama

Tuskegee University (formerly Tuskegee Institute), Department of Biology. The University is involved in a project, funded by the Department of Energy, titled: "Response of Vegetation to Carbon Dioxide; Field Studies of Sweet Potato in Response to Elevated Carbon Dioxide." The Sigma Xi Chapter, along with twenty other chapters, is involved in a teleconference on the effects of increases of carbon dioxide in the atmosphere. The primary sites will receive both video and audio from a central studio in Virginia (WETA). A program will be presented by four specialists in the field, followed by a question and answer session. Undergraduate training and courses will be available in Recombinant DNA Technology, Cytogenetic Technology, and Electron Microscopy Technology. *Dr. Julian Thomas, Dr. John Davidson,* and *Dr. Helen Benford* will supervise the Recombinant DNA program. The Cytogenetic Technology program is under the supervision of *Dr. John W. Williams,* currently on a sabbatical leave at the University of Minnesota, and *Dr. Velma Richardson.* Dr. Richardson spent last summer working at Oak Ridge National Laboratory in cytogenetics. *Mrs. Carol Williams* is the director of the Electron Microscopy Technology program.

Auburn University, Department of Botany, Plant Pathology, and Microbiology. *Dr. David M. Bisaro* was an invited participant in the Gordon Conference on Plant Molecular Biology at Andover, New Hampshire. He presented results from his research on plant molecular genetics. *Dr. Rodrigo Rodriguez-Kabana* was inaugurated as President of the Organization of Tropical American Nematologists at the 17th annual meeting of the organization held this past summer at Port-of-Spain, Trinidad. *Dr. Wanzer Drane,* Professor in the Department of Statistics at Southern Methodist Univ., will be a visiting Professor in the department and in the Department of Research Data Analysis during 1985–86. He will teach courses and serve in a research consultative capacity in biostatistics. *Dr. John D. Freeman* has been awarded a sabbatical leave for one year. He will be studying at various herbaria throughout the eastern United States, including the Smithsonian and Harvard, to complete several research projects in plant taxonomy.

Florida

University of Florida, Department of Botany. *Dr. Indra K. Vasil* has received an $80,000 grant from the Monsanto Corporation to continue studies on tissue culture of cereal crops. *Dr. John J. Ewel* was awarded a Guggenheim Fellowship for the 1985–86 academic year. He will be pursuing research interests at Cambridge University. *Dr. William Louis Stern* resigned from the Chairmanship of the Department and *Professor James W. Kimbrough* is serving as Acting Chair until an outside search is complete. At the recent AIBS meetings held at the University, *Dr. W. Mark Whitten,* a former graduate student, received the Ralph Alston Award for his dissertation research and paper presented on the phytochemistry of fragrances and systematics of *Gongora* (Orchidaceae). More than 1800 registrants participated in the AIBS meetings, hosted by The University of Florida. Campus Chairman for the event was Professor Kimbrough.

University of South Florida, Department of Biology. *Dr. Clinton J. Dawes* has been appointed Chairman. *Dr. Larry Brown* has received two-year grants to prepare, "A Guide to Florida Mammals" and "A Guide to Common Florida Lepidoptera." During the 1984–85 academic year, the Department hosted several outstanding seminar speakers. Among them were *Dr. Hal Mooney,* Stanford University, *Dr. Tom Eisner,* Cornell University, and *Dr. Arthur Bell,* Kew Gardens. *Dr. Diane Te Strake* and *Robert Mattson* participated in the 4th International Symposium of Marine Mycology in Portsmouth, England. *Dr. Fred Essig* was a member of the China-U.S. Horticulture Exchange delegation. They visited many Botanical Gardens in Mainland China during July 1985.

Archbold Biological Station, Lake Placid. *Dr. James L. Wolfe,* formerly Director, Mississippi State University Research Center at National Space Technology Laboratories, assumed the position of Executive Director on August 1, 1985. *Dr. James N. Layne,* formerly Executive Director of the Station, remains on the staff as Senior Research Biologist.

Bureau of Marine Research, St. Petersburg. A symposium on the biology and fishery of the commercially valuable stone crab (*Menippe mercenaria*), sponsored jointly by the Florida Department of Natural Resources, Florida Sea Grant Program, and Mote Marine Laboratory, will be held at Mote Laboratory in Sarasota, Florida, April 24–25, 1986. For further information, contact *Dr. Theresa M. Bert,* Florida Dept. of Natural Resources, Bureau of Marine Research, 100 8th Ave. S.E., St. Petersburg, FL 33701. Phone: (813) 896-8626.

Georgia

Valdosta State College, Department of Biology. *Dr. Wayne R. Faircloth,* Professor of Biology and Curator of the Herbarium, was recently appointed Chairman. *Dr. J. Richard Carter* (Ph.D. Vanderbilt University), has joined the faculty as a botanist, and in addition to his teaching will be assuming most of the curatorial work in the Herbarium. Dr. Carter's research interests deal with the biosystematics of *Cyperus. Dr. Clyde Eugene Connell,* Emeritus Professor of Biology, died on May 22, 1985. Dr. Connell was widely known for his ecological investigations dealing with lipid metabolism in migrating birds.

Illinois

Southern Illinois University, Botany Department. "FIELD ECOLOGY STUDIES in the northern Rocky Mountains." Enjoy 6½ weeks in the spectacularly scenic and diverse northern Rocky Mountains studying ecological characteristics of shrub-desert, grassland, coniferous forest, and alpine tundra ecosystems. This course should appeal to students majoring in Botany, Zoology, Biology, Forestry, Conservation, and Wildlife Biology and is designed to develop field capabilities by teaching plant identification, field ecology methods, and landscape interpretation. Many students, who have taken this course, have found that it has enhanced their ability to find jobs, particularly in the western United States. Students will earn 6 semester hours of upper level credit. Total cost will be about $140.00 per week which includes travel to and from Carbondale, Illinois, tuition, books, fees, room and board, and travel expenses. Out-of-state students pay the same tuition as Illinois residents. The total cost for the course and living expenses is in line with the total cost for an on-campus course. Base of operation for the course will be the YBRA Field Camp located at the foot of the Beartooth Mountain near Red Lodge, Montana. For more information, contact by March 15, 1986: Dr. P. A. Robertson, Dept. of Botany, Southern Illinois University, Carbondale, IL 62901 (618/536-2331).

Kentucky

Western Kentucky University, Department of Biology. *Dr. Valgene L. Dunham* is the new Department Head. He earned his M.S. and Ph.D. degrees at Syracuse University of New York in general science and botany, respectively. His current post is Professor and Coordinator of Recombinant Gene Technology, Fredonia State University College, Fredonia, New York. The Biology Scholarship Fund, started several years ago by pledges from the faculty, has now grown to over $20,000, and the earnings from this fund are providing a number of $500 scholarships to deserving majors. *Dr. Basil C. Cole,* a former faculty member, and his wife have made significant gifts in the form of an endowment to support biology students. These awards will provide a significant number of scholarships for biology majors during the present academic year. Dr. Cole has retired as Vice President of 7-Up Bottling Co. The Kentucky Dept. of Fish and Wildlife Resources has made two grants to two faculty members. *Dr. Herb Shadowen* completed a survey of Kentucky Deer Hunters, and *Dr. Larry Gleason* is currently conducting a Hunter/Harvest Survey. The Ogden College of Science, Technology, and Health has a new Dean. *Dr. Charles E. Kupchella* will assume the responsibilities of the deanship after being selected from a wide field of applicants. He comes from Murray State University, where he was Chairman of the Department of Biological Sciences. His Ph.D. is from St. Bonaventure University of New York. Post-doctoral work was done at the University of Illinois–Urbana. *Dr. Gary Dillard* will return to full-time teaching this Fall, after having served as Assistant Dean of the Graduate College, and more recently as Associate Dean of the Ogden College of Science, Technology, and Health.

Louisiana

University of Southwestern Louisiana, Biology Department. *Dr. John W. Fuseler* has joined the Biology faculty as Associate Professor. He received his Ph.D. from The University of Pennsylvania and has held several positions since then, including postdoctoral appointments at Woods Hole, Massachusetts, and The University of Texas Medical Branch, Galveston, Texas. *Dr. Keith R. Robers* has been awarded an NSF grant for $80,000 for a three-year study of the three-dimensional structure of the flagellar apparatus in dinoflagellate algae. A long-term goal is to incorporate information on the flagellar apparatus into a comprehensive evolutionary analysis of dinoflagellates and other algae and protozoa. *Dr. Tetsukazu Yahara* (Botanical Garden, University of Tokyo) worked with *Dr. Victoria I. Sullivan* this past summer, as Visiting Research Scientist. They began a joint project to characterize allozymes, isozymes, and karyotypes of *Eupatorium*, as the genus occurs in eastern Asia and eastern U.S., and to measure genetic distances among the species.

Louisiana State University, Baton Rouge, Department of Botany. *Dr. Shirley C. Tucker*, Boyd Professor of Botany, has been elected President-Elect of the Botanical Society of America, and will become President in August 1986. *Dr. Keith Clay* attended the 4th International Symposium on the Microbiology of the Phyllosphere held in Wageningen, Netherlands in September 1985. *Dr. Russell L. Chapman* presented invited research seminars in the Departments of Biology at Texas Christian University in Dallas, and at the University of Puerto Rico, Mayaguez, and the Department of Marine Sciences at the Marine Sciences Field Station on Magueyes Island, PR. *Dr. Mary Jane Saunders* presented a research paper at the NATO Conference on the Molecular and Cellular Aspects of Calcium in Plant Development and received the award for the best presentation at the conference. *Dr. Elizabeth Gantt*, Smithsonian Environmental Research Laboratories, Maryland, presented a seminar during a site visit in preparation for the Annual Meeting of the American Society of Plant Physiologists to be held at LSU in June 1986. Dr. Gantt is the Vice President of the organization. The Botany greenhouses are now completed and provide the faculty and graduate students with much needed space for research projects. *Dr. Thomas S. Moore*, Chairman of the Department, has joined the Editorial Board of the Archives of Biochemistry and Biophysics. *Dr. Peter Raven*, Director of the Missouri Botanical Garden in St. Louis was a guest speaker and spoke on "Deforestation—Crisis in the Tropics" and on "The Evolution of Higher Plants."

McNeese State University, Department of Biological and Environmental Sciences. The department has entered into a 2-year Cooperative Research Agreement with the USDA-ARS Insects Affecting Man and Animals Research Laboratory in Gainesville, Florida. The project, headed by *Roger S. Nasci* and *Michael Vecchione*, is designed to study the use of microsporidian parasites of mosquitoes as potential biocontrol agents, the habitat associations of mosquito larvae, and the copepods serving as intermediate hosts for the parasites.

Mississippi

Gulf Coast Research Laboratory, Ocean Springs. Students representing 17 colleges and universities in 11 states participated in this past summer's field course programs. The Laboratory's courses have become a part of the academic offerings of 60 colleges and universities throughout the south and central U.S.

Mississippi State University, Department of Biological Sciences. *Dr. H. Wyman Dorough* is the new Head of the Department. *Dr. Lew Brown* has been serving as Acting Department Head for the past year. Dr. Dorough served as Professor of Entomology and Toxicology in the School of Biological Sciences at the University of Kentucky. Prior to that, he taught at Texas A&M University. *Dean Edward L. McGlone*, of the College of Arts and Sciences, said "Dr. Dorough is internationally recognized for his research on the chemical alteration and biological stability of pesticidal chemicals." Dr. Dorough has published more than 125 research articles, and has received grants for more than 1.3 million. He helped establish the Graduate Center for Toxicology at Kentucky and served as its Director for seven years. He received his B.S. and M.S. from Auburn University, and his doctorate from the University of Wisconsin.

North Carolina

North Carolina State University, Department of Zoology. *Dr. James A. Rice* has joined the faculty replacing *Dr. David DeMont.* Dr. Rice earned his Ph.D. and completed postdoctoral training at the University of Wisconsin. He will be responsible for conducting research and extension activities in freshwater fisheries.

University of North Carolina, Institute of Marine Sciences. (*Note: the following item is a correction of news which appeared in the July 1985 issue.) *Dr. C. Peterson,* Professor, spent December and part of January 1985 in Western Australia continuing comparative clam ecological studies. *Dr. Frank Schwartz,* Professor and Ichthyologist, spent January 1985 in India presenting papers on sea turtles at the Symposium on Endangered Marine Animals and Marine Parks, Cochin. Sea turtle research was conducted at Point Calimar, southeast coast following the symposium. Dr. Schwartz traveled to Czechoslovakia in March, and Russia in April 1985, as part of the U.S. National Academy of Sciences and eastern European Academics exchange programs where fish and fish hybridization studies were emphasized.

Wake Forest University, Department of Biology. *Dr. Raymond E. Kuhn* has been elected as a Council Member at Large of the Society of Parasitologists. He joins *Dr. Gerald W. Esch* on the Council. On October 4th and 5th, Wake Forest held its First Annual Symposium on Perspectives in Biology. Featured speakers were *Dr. Malcolm Brown,* holder of the Johnson & Johnson Centennial Chair in Biology at the University of Texas; *Dr. Ruth Patrick,* Director of the Partrick Center for Environmental Research of the Academy of Natural Sciences of Philadelphia, and *Dr. Bruce Wallace,* University Distinguished Professor at Virginia Polytechnic Institute and State University at Blacksburg. Wake Forest is initiating the annual series to bring together the faculties of North Carolina's colleges and universities for professional enrichment and social interaction. At each symposium three internationally renowned biologists will present two lectures each on their specialties.

South Carolina

College of Charleston (Grice Marine Biological Laboratory), Department of Biology. *Dr. Susan J. Morrison* was a member of a Goodwill People-to-People delegation composed of health profession advisors which visited medical facilities and schools in Helsinki, Finland; Leningrad and Moscow, U.S.S.R.; Beijing and Shanghai, People's Republic of China, and Tokyo, Japan. *Dr. Harry W. Freeman* has been extended an invitation by the Ministry of Agriculture, Animal Husbandry, and Fisheries of the People's Republic of China to be a member of a delegation that will visit producers, marketers, and researchers in Beijing, Chengdu, and Yuangzhou. The fall, 1985, visit will also include Hong Kong.

Francis Marion College, Department of Biology. *Dr. Lynn M. Croshaw* has prepared life-size plaster reconstructions of extinct organisms for study and the enjoyment of visitors to the College. The history of vertebrate life is often a difficult concept to fully appreciate. Quite often the taxonomic names and scientific descriptions frustrate the student's attempts to clearly envision the general trends and sequence of the ancestral vertebrate types which have led to our present-day fauna. It is easy to recite eight taxonomic classes in phylogenetic sequence and associate extant forms, where applicable, to those groups. However, to understand their true evolutionary relationship requires a familiarity with the ancestral, extinct members of these classes. Organisms which lived 500 million years ago, or anytime up to the recent in man's memory, are difficult to appreciate without a visual experience of their forms. It is also difficult to accept the sequence of these forms in the accepted phylogenetic line leading to present-day organisms. Experience has also shown that everyone's interest, enjoyment, curiosity, and scientific questions are stimulated by meaningful exhibits available to them. It is with this broad purpose in mind that Dr. Croshaw prepared the life-size plaster reconstructions, along with other materials consistent with a natural history collection. The early history of dominant Cambrian life is reflected in the trilobite collection which is then followed by an emphasis on vertebrate phylogeny. Stages of ostracoderm evolution consist of five replicas of the Anaspida,[1] eight of the Heterostraci,[2] and eight of the Osteostraci[3] extending from the Ordovician into the Devonian. Six genera of the Acanthodii[4] and four of the Placodermi[5] demonstrate the progressive development through the Silurian. Early dipnoan[6] forms from the Devonian were reconstructed into a collection of six genera, and seven examples of the Crossopterygii[7] from the Devonian are included together with *Latimeria* of the present age. The three extant examples of lungfish[8] are also a part of this collection. Progressive trends in morphologic development within the respective groups are particularly well demonstrated among these lesser known Paleozoic vertebrates. Amphibian development is studied from *Ichthyostega* and *Diplovertebron* of the Devonian, *Sauropheura* (Carboniferous), *Diplocaulus* (Permian), and *Eupelor* (Triassic). *Seymouria* is included as the type transitional to the reptiles. Illustrating the early avian development, *Saltopsuchus* is used to show the general reptilian ancestry from the Triassic. The hypothetical proavis demonstrates the transition to *Archaeopteryx* of the Jurassic. Cretaceous forms are shown by *Hesperornis* and *Ichthyornis*. The trend toward mammalian evolution is illustrated in a reconstructed series of reptilian replicas which begins with *Dimetrodon* of the Permian and *Thrinaxodon* of the Triassic. Further stages are shown by the mammalian replicas of *Ornithorhynchus, Macrotis*, and *Triconodon* (Jurassic). Additionally, other areas of biological interest are rapidly being developed to broaden the basis of this collection. This includes life-size reconstructions of the extinct or rare birds such as the Dodo, Ivory-billed Woodpecker, Swallowtail Kite, Carolina Parakeet, Bachman's Warbler, and the Bald Eagle. Many preserved and mounted birds of the Pee Dee, SC, are also on display. Cystoid replicas of the Devonian, casts of mammalian tracks, replicas of twenty-five different species of snakes of the Pee Dee, an extensive shell collection, replicas of 120 different bird eggs of the area, and other miscellaneous common biological collections add to the awareness of our living world. Present efforts are being directed to a collection of fossils excavated and catagorized from this local area, and the expansion of all exhibits already established. Immediate future plans will be devoted to the interests of botany and microbiology.

[1] *Birkenia, Pterolepis, Pharyngolepis, Lesanius*, and *Jamoytius*.

[2] *Lanarkia, Thelodus, Phlebolepis, Drepanaspis, Phyllolepis, Pteraspis, Doryaspis*, and *Anglaspis*.

[3] *Tremataspis, Tyriaspis, Hemicyclaspis, Boreaspis, Kiaeraspis, Axinaspis, Acrotomaspis*, and *Nectaspis*.

[4] *Climatius, Diplacanthus, Ischnacanthus, Triazeugacanthus, Homalacanthus*, and *Acanthodes*.

[5] *Pterichthys, Bothriolepis, Dinichthys*, and *Coccosteus*.

[6] *Dipterus, Griphognathus, Fleurantia, Phaneropleuron, Uronemus*, and *Conchopoma*.

[7] *Holoptychius, Gyroptychius, Osteolepis, Rhizodopsis, Eusthenopteron, Strunius*, and *Latimeria*.

[8] *Protopterus, Lepidosiren*, and *Neoceratodus*.

Tennessee

The University of Tennessee, Department of Botany. *Dr. A. J. Sharp* has been invited to be one of the leading participants in an "International Symposium on Bryology" to be held at Panjab University, Chandigarh, India in February, 1986. The American Bryological and Lichenological Society presented their first annual prize, named in honor of A. J. Sharp, to *Bruce H. Allen*, of the Missouri Botanical Garden, for the best student paper presented at their annual meeting at the University of Florida in August, 1985. *Dr. Raymond Holton* has retired as Head of Botany. He will continue to serve as Co-chairman of the interdisciplinary programs in Biology, and will return to teaching and research. *Dr. Karen Hughes* will replace him as Head. Visiting faculty in the Department include *Dr. Larry Geismann*, Northern Kentucky Univ.; *Dr. Eva Cellarova*, Czechoslovakia; *Victor Ma*, People's Republic of China; and, *Li-Yun Lu*, Taiwan. The Department is publishing a biannual newsletter. For further information, write Dept. of Botany, UTK, Knoxville, TN 37996-1100.

The University of Tennessee, Department of Forestry. The Sixth Central Hardwood Forest Conference will be held at the University on February 24–26, 1987. It will be sponsored by the Department of Forestry, Wildlife and Fisheries; Society of American Foresters; Department of Botany; and the Southern Forest Experiment Station. Papers dealing with hardwood forests and forestry are invited. Subject areas will include: silviculture; hydrology, soils, and nutrient cycling; habitat management for wildlife, recreation, and livestock; protection from fire, diseases, pests, and pollution; inventory, yield and stand dynamics; biology, genetics, and physiology; ecology and productivity; logging and products; and economics, marketing, and market development. Abstracts should be submitted before March 1, 1986. Papers accepted will be peer-reviewed and published in the proceedings. All correspondence and inquiries should be addressed to: *Dr. Ronald Hay*, Chairman, Sixth Central Hardwood Forest Conference, Dept. of Forestry, Wildlife & Fisheries, The University of Tennessee, P.O. Box 1071, Knoxville, TN 37901.

Virginia

Virginia Commonwealth University, Department of Biology. *Dr. Jackson E. Jeffrey* has been named Chairman of the Department of Biology effective August 16, 1985.

ABOUT MUSEUMS AND BOTANICAL GARDENS

Alabama

Anniston Museum of Natural History. On January 10th through Februay 9th, 1986, the Museum will feature an exhibition entitled "Asen, Iron Altars of the Fon People of Benin." Forty African funerary sculptures with a variety of human and animal figures depict African art and culture. The exhibition is from the William Arnett Collection on loan from Emory University, Atlanta, Georgia.

Kentucky

Museum of History and Science, Louisville. *Dr. William "Mac" Sudduth,* President of the Museum, has been named to the Kentucky Humanities Council Board. The Council reviews and develops program policies, and reviews grant proposals received by the Kentucky Humanities Council. The first sailing on the Halley's Comet Cruise has sold out. In response to popular demand, the consortium of sponsoring museums has added another sailing. The Caribbean cruise, February 26–March 9, will offer opportunities for comet watching and photography under ideal conditions, far from the light pollution of large metropolitan areas. Total cost of the 12-day expedition ranges from $2,095 to $2,795, depending upon cabin accommodations. For more information, contact *Liz Wideman* at the Museum of History and Science, 727 West Main St., Louisville, KY 40202, (502) 589-4584. Another expedition will also be sponsored by the Museum from January 11–22, 1986. On this trip, you will be among the first Americans ever to see the extraordinary sight of tens of millions of monarch butterflies wintering in the mountains west of Mexico City. The Safari, lead by *Dr. Hal Mahan,* is an outstanding introduction to the ecology and conservation of wildlife in Mexico. Dr. Mahan has been the Director of the Cleveland Museum of Natural History since 1973. He is a zoologist and a Fellow of the Explorers Club. The Museum announced the receipt of a $225,000 grant from Brown-Forman Incorporated. The funds were given to the Museum for that institution's fund drive to implement the long-range plan passed in March 1985. The Bingham Foundation has granted $75,000 for the Museum's capital fund drive to provide the initial development of the Falls-of-the-Ohio area on the fourth floor. The Junior League of Louisville has given a $56,000 grant to the Museum.

Mississippi

The Crosby Arboretum, Hattiesburg. Describing his design as "an abstract forest," architect *Fay Jones* presented a model and schematic drawings of the Crosby Arboretum's Interpretive Center at the Spring Board of Directors meeting. Consisting of a cluster of structures to house public activities as well as research and staff functions, the plan features an open-air pavilion, multi-purpose visitors center, office building, and maintenance facility. The Chisolm Foundation of Laurel, Mississippi, has awarded The Crosby Arboretum a grant of $5000 for the planning of a model educational program. Superintendent *Chris Wells* represented The Crosby Arboretum at the Conference on Landscaping with Native Plants, held this past summer at Western Carolina University at Cullowhee, NC. The conference investigated the use of native southeastern plant species in beautification projects, emphasizing such large-scale efforts as highway rights-of-way and public parks. Hurricane Elena passed directly over the Arboretum site. An initial look at the situation is quite encouraging. Although some trees were lost at the main site, the damage was less than anticipated. The outlying natural areas seem to have weathered the storm reasonably well.

South Carolina

Brookgreen Gardens, Murrerlls Inlet. Two new additions to the staff are *Deborah Sue Griffin* and *Pamela Grubbs* as Education Coordinators. They are in charge of the educational programs of the Gardens and administer the Volunteer Program. Working together, they provide programs to visitors, members and school groups. Ms. Griffin has a B.S. in Biology from the University of North Carolina at Charlotte. She has extensive background in ornithology, raptor rehabilitation, and veterinary surgical procedures. Ms. Grubbs holds her B.S. in Zoology from North Carolina State University in Raleigh. Her experience is in the areas of wildlife and conservation management.

ANNOUNCING
MOUNTAIN LAKE BIOLOGICAL STATION SUMMER FIELD COURSES 1986

First Term (June 15–July 19)

Behavioral Ecology
Ronald Pulliam, University of Georgia
Jerry O. Wolff, University of Virginia
Biology of Insects
George W. Byers, University of Kansas
Herpetology
Hubert Keen, SUNY–Cortland
Workshop in Allozyme Techniques
Ramone Baccus, Yavapai College

Second Term (July 20–August 22)

Evolutionary Genetics
Bruce Grant, College of William and Mary
Natural History of the Southern Appalachians (undergraduate course)
Robert C. Simpson, Lord Fairfax Community College
Quantitative Methods in Field Biology
Joseph Travis, Florida State University
Henry Wilbur, Duke University
Nature Photography (undergraduate course)
Robert C. Simpson, Lord Fairfax Community College
Workshop in Allozyme Techniques
Charles R. Werth, University of Kansas

Scholarships Available:—Service Awards for students covering room and board costs.
—Post-Doctoral Research Awards (10 weeks)
—Post-Doctoral Fellowships for summer research in Evolutionary Biology. Deadline for applications March 1.

For further information and application write to:

Dr. Blaine J. Cole, Director
Mountain Lake Biological Station
Gilmer Hall
University of Virginia
Charlottesville, VA 22901

APPLICATION FOR ASB MEMBERSHIP

Give copies of this to your students, colleagues, and your school librarian.

Fill out blanks and enclose check or money order for one year's dues and mail to Dr. R. L. Beckmann, Dept. of Botany, N.C. State Univ., Raleigh, N.C. 27695-7612.

Name in full ____ Date __________

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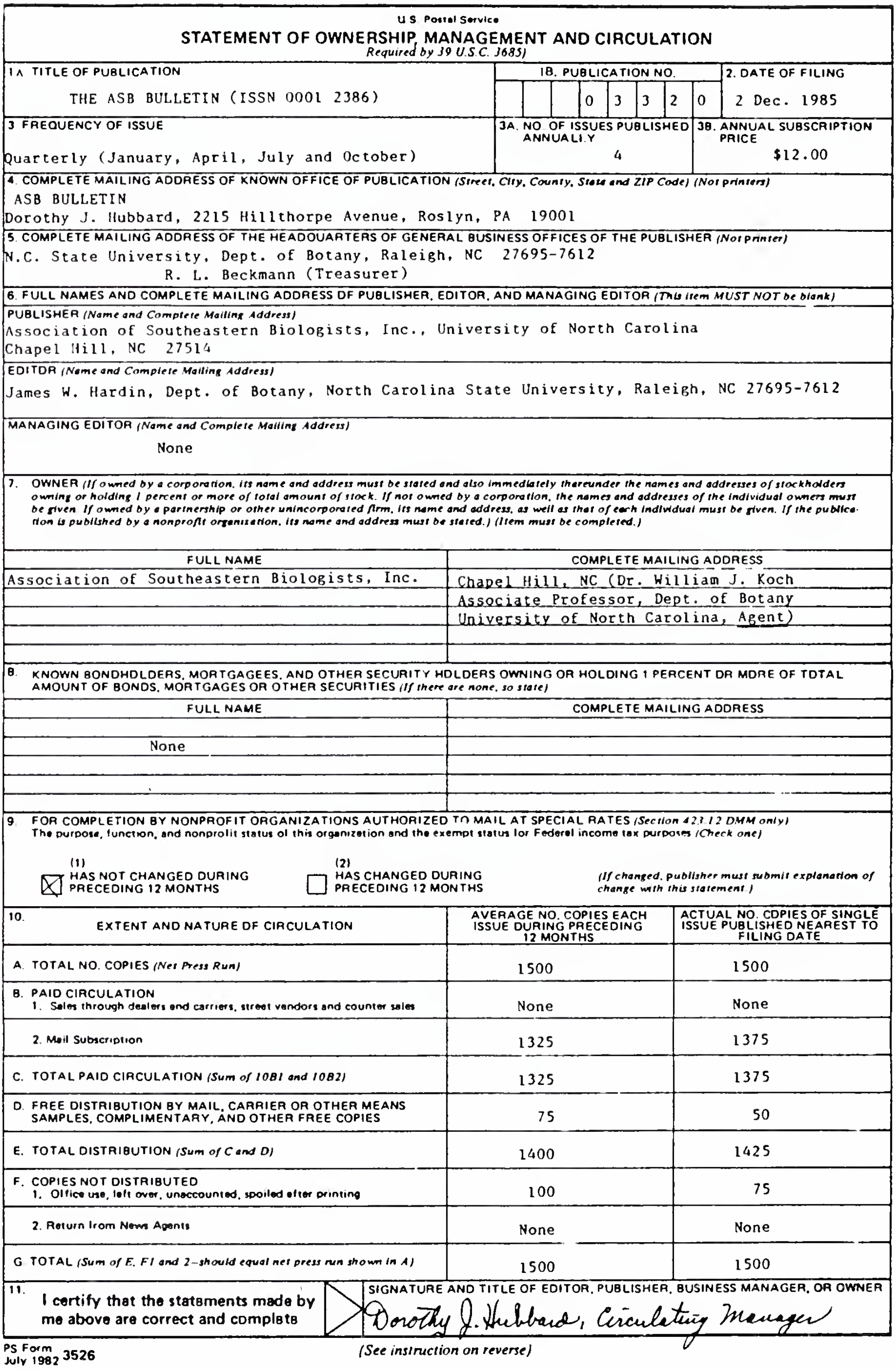

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James W. Hardin, Dept. of Botany, North Carolina State University, Raleigh, NC 27695-7612

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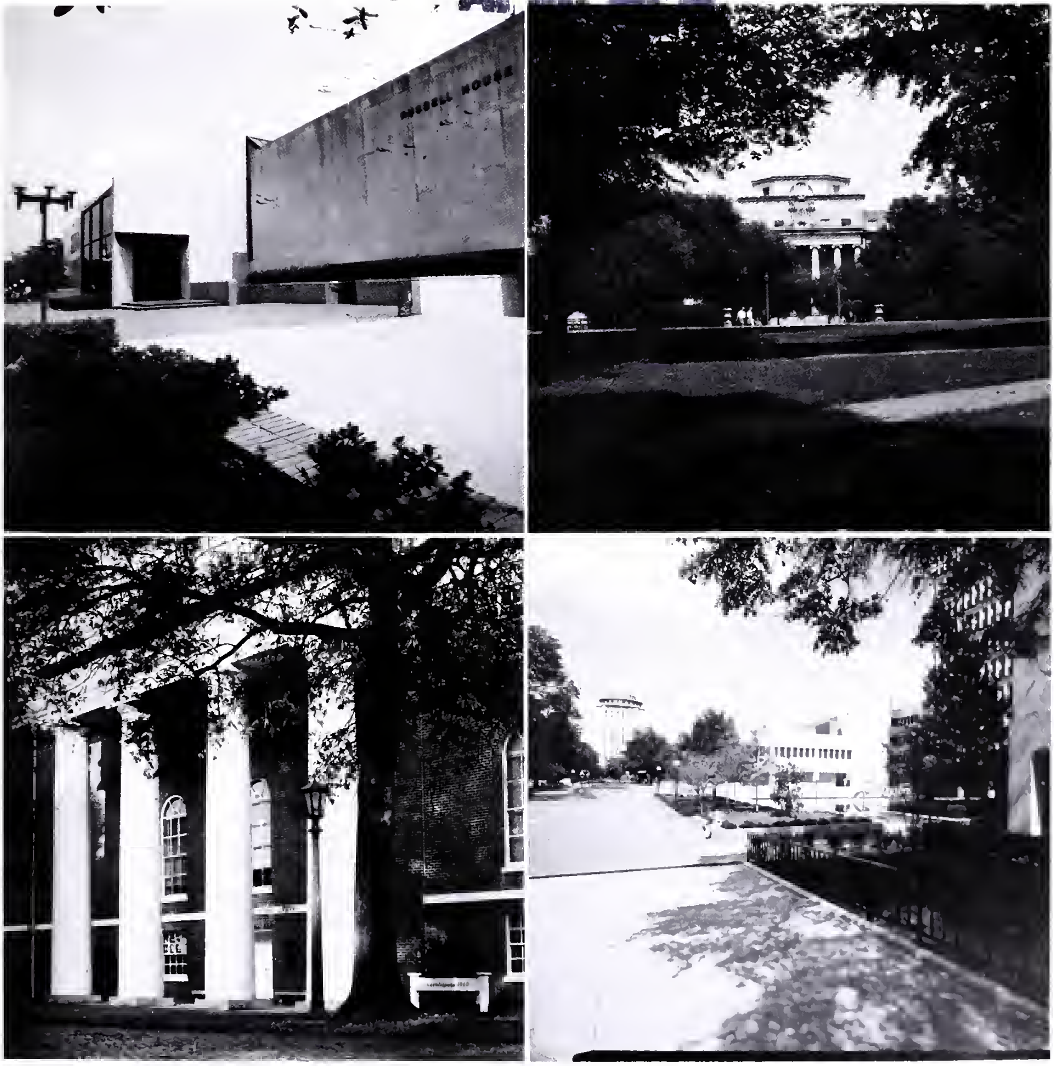

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COVER

University of South Carolina campus.

Top left: Russell House (Student Union); *top right:* McKissick Museum (University museum, art gallery, and archives); *lower right:* Patterson Mall (Humanities Complex); *lower left:* The South Caroliniana Library (1840, designed by Robert Mills, the first separate college library built in America).

TIME AND PLACE OF FUTURE MEETINGS

1987	University of Georgia, Athens (50th Anniversary)

PATRON MEMBERS

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Program of the 47th Annual Meeting of the Association of Southeastern Biologists

University of South Carolina

SOCIETIES MEETING WITH ASB IN COLUMBIA

American Society of Ichthyologists and Herpetologists, Southeastern Division
Beta Beta Beta, Southeastern Region
Botanical Society of America, Southeastern Section
Ecological Society of America, Southeastern Chapter
Southeastern Fishes Council
Southern Appalachian Botanical Club

GENERAL INFORMATION

Registration—Registration for the 47th annual meeting of the Association of Southeastern Biologists, purchase of tickets for the banquet, breakfasts, luncheons, and other special events should have been arranged through pre-registration with the Local Arrangements Committee. Pre-registrants may obtain their information packet and tickets at the Carolina Inn (Radisson) registration desk on Wednesday, April 9 from 5:00 P.M. until 10:00 P.M. On Thursday and Friday, April 10 and 11, from 7:30 A.M. to 5:00 P.M. and 8:00 A.M. to 12:00 noon, respectively, packets and tickets will be available at the ASB registration booth in the Ballroom on the second floor of Russell House. Late registration is possible at these times and locations. Late registration fees are $8.00 for students and $12.00 for regular members. Please bring your *ASB Bulletin* (April, 1986) to the meeting as free copies will not be available at USC. Extra copies may be purchased at the ASB registration booth for $3.00 each.

Parking and Shuttle Service—ASB participants and guests may park in metered spaces on the streets and in metered USC lots; these usually fill early. Parking is also available in a City of Columbia lot ($0.50/day) located on the northwest corner of Greene and Park Streets; this lot is 5 blocks from Russell House. A USC shuttle stops on this corner and will deliver you within about one block of Russell House. A shuttle service will run from Carolina Inn, Holiday Inn, and Town House at 30 minute intervals on Thursday and Friday (7:00 A.M. to 9:00 A.M.; returning 4:00 P.M. to 6:00 P.M.). If you are staying in Carolina Inn or

Holiday Inn, either walk or use the shuttle as you probably will not be able to park any closer.

Placement Service—Message boards are available in the Ballroom on the second floor of Russell House for those wishing to post job announcements and for those seeking positions.

Dining and Lounge Facilities—Meals may be obtained on the university campus at Russell House and Faculty House. In addition, excellent dining facilities may be found at Carolina Inn (Radisson) and at other establishments throughout Columbia listed in the registration packet. A map showing the location of fast food outlets in the vicinity of the USC campus is also included in the registration packet.

Social Activities for Conference Guests—On Thursday and Friday, organized and unorganized activities are available for guests not participating in the meetings or sessions.

Historic Columbia Foundation Tours, 1616 Blanding Street. Contact: Linda Morgan (252-7742).
Riverbanks Zoo, the nationally famous, award-winning zoo has recently been listed in the top 10 zoos in the United States. Contact: Mary Leverette (779-8717).
Columbia Museum of Arts and Sciences, 1112 Bull Street. Contact: Mark Tucker (799-2810).

Historic Home and Garden in downtown Columbia featuring pit-cooked barbecue, beer, and excellent jazz. Carolina Alive Singers will also appear. If you did not pre-register, inquire early about possible reservations (Thursday, 6:00 P.M.–9:00 P.M., $11.00).

The ASB Banquet—The ASB Banquet and program will be held in the Columbia Ballroom of the Carolina Inn (Radisson).

Field Trips—Field trips this year commemorate the 50th Anniversary of the Southern Appalachian Botanical Club.

Wednesday, April 9, 1986:

(1) Savannah River Ecology Laboratory (SREL) and Savannah River Plant (SRP) (9:00 A.M.–4:00 P.M.)—$5.00; trip will *meet at SREL,* near Aiken, SC (see January issue of the ASB Bulletin for important details). All other field trips will leave from the Carolina Inn (Radisson).
(2) Congaree Swamp National Monument (1:30 P.M.–5:00 P.M.)—$2.00.

Saturday, April 12, 1986:

(3) Stevens Creek Natural Area and Savannah River Bluffs (8:00 A.M.–5:00 P.M.)—$10.00.
(4) Peachtree Rock and Shealy's Pond Preserves (8:00 A.M.–3:00 P.M.)—$6.00.
(5) Flat Creek Natural Area and Forty Acre Rock (8:00 A.M.–5:00 P.M.)—$10.00.

Tickets for Scheduled Meals and Events—Pre-registrants will receive the requested meal and special event tickets with their registration packets. A *limited* number of tickets for some events will be available for those who did not pre-register.

BREAKFASTS, LUNCHEONS, AND SPECIAL EVENTS

Southeastern Chapter of the Ecological Society of America (Friday luncheon)—$8.00; Southern Appalachian Botanical Club (*50th Anniversary*) and Southeastern Section, Botanical Society of America (Friday breakfast)—$7.25; Beta Beta Beta (Friday luncheon)—$6.00; Garden Party Barbeque in Historical Columbia (Thursday evening)—$11.00; ASB Banquet (Friday evening)—Student $10.00, Regular $12.00.

Useful Telephone Numbers (Area Code 803-)

Russell House University Union Information	777-3196
All Emergencies	777-5222
Department of Biology	777-4141
Faculty House	777-7328
Carolina Inn (Radisson)	799-8200
Columbia Marriott Hotel	771-7000
Governor's House	779-7790
Heart of Columbia	799-1140
Holiday Inn, City Center	799-7800
The Town House	771-8711

Local Arrangements Committee—

Co-chairmen:	John M. Herr, Jr.	(803) 777-8110
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Pre-registration and Registration:	Gerald T. Cowley	-3167
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	Richard G. Zingmark	-4873
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Social Activities:	David H. Husband	-4255
Transportation and Parking:	E. Fontelle Thompson, Jr.	-5153
Accommodations:	Robert J. Feller	-3937
Host Motel and Meeting Headquarters:	Carolina Inn (Radisson) 937 Assembly Street Columbia, SC 29201	799-8200

Program Summary

WEDNESDAY, APRIL 9, 1986

5:00 P.M.–10:00 P.M.	Registration, Carolina Inn (Radisson)
6:00 P.M.–9:00 P.M.	Social Mixer with Cash Bar, Mezzanine, Carolina Inn (Radisson)
7:00 P.M.	Executive Committee Meeting, Carolina Inn (Radisson)
9:00 A.M.–1:30 P.M.	Field Trips

THURSDAY, APRIL 10, 1986

7:30 A.M.–5:00 P.M.	Registration, Russell House Ballroom
7:00 A.M.	Past President's Breakfast, Faculty House
8:00 A.M.–5:00 P.M.	Placement Service: Russell House Ballroom
8:30 A.M.–9:45 A.M.	**General Plenary Session**, Law School Auditorium, ***Air Pollution Effects on Southeastern Forests: Current Status.*** Presented by *Dr. Ellis B. Cowling,* Department of Plant Pathology and School of Forest Resources, North Carolina State University, Raleigh, NC.
8:00 A.M.–5:00 P.M.	Exhibits, Russell House Ballroom

Paper Sessions: Russell House

10:00 A.M.–12:00 A.M.	Plant Ecology, Session I, Room 303
10:00 A.M.–11:45 A.M.	Plant Ecology, Session II, Room 305
10:00 A.M.–11:45 A.M.	Plant Systematics, Session I, Room 332
10:00 A.M.–12:00 P.M.	Aquatic Ecology, Session I, Room 327
10:00 A.M.–11:15 A.M.	Cytology/Genetics, Session I, Room 203
10:00 A.M.–12:00 P.M.	Parasitology/Microbiology, Session I, Room 202
1:00 P.M.–4:00 P.M.	Symposium, Russell House Theater, *Blackwater River Ecosystems.* Cosponsored by the Southeastern Chapter of the Ecological Society of America and ASB. Organized by Courtney Hackney.
1:00 P.M.–4:45 P.M.	Ichthyology/Herpetology, Session I, Room 203
1:30 P.M.–4:00 P.M.	Animal Physiology, Session I, Room 202
1:00 P.M.–4:30 P.M.	Plant Ecology, Session III, Room 327

Special Meetings

4:00 P.M.–5:00 P.M.	Forum for Herbarium Curators and Users in the Southeast, Russell House, Room 303
4:15 P.M.–5:15 P.M.	Business Meeting, Southeastern Chapter of the Ecological Society of America, Russell House Theater
6:00 P.M.–9:00 P.M.	Historic Home and Garden Party: Barbecue, Beer and Jazz

FRIDAY, APRIL 11, 1986

7:00 A.M.–9:30 A.M.	Breakfast and Business Meeting: Southern Appalachian Botanical Club (50th Anniversary) and Southeastern Section, Botanical Society of America, Carolina Inn (Radisson)

8:00 A.M.–9:00 A.M.	Business Meeting: Southeastern Division of the American Society of Ichthyologists and Herpetologists, Russell House Theater
9:00 A.M.–10:00 A.M.	Business Meeting: Southeastern Fishes Council, Russell House Theater
8:00 A.M.–12:00 A.M.	Late Registration, Russell House Ballroom
8:00 A.M.–5:00 P.M.	Placement Service, Russell House Ballroom
8:00 A.M.–5:00 P.M.	Exhibits, Russell House Ballroom

Paper Sessions: Russell House

8:30 A.M.–11:00 A.M.	Invertebrate Zoology, Session I, Room 305
8:30 A.M.–11:00 A.M.	Aquatic Ecology, Session II, Room 202
9:45 A.M.–10:45 A.M.	Teaching, Session I, Room 303
9:45 A.M.–10:45 A.M.	Plant Systematics, Session II, Room 332
9:45 A.M.–11:00 A.M.	Plant Ecology, Session IV, Room 327
10:00 A.M.–11:00 A.M.	Ichthyology/Herpetology, Session II, Room 203

Poster Session: Russell House

10:00 A.M.–5:00 P.M.	Poster Session I, Room 203 Alcove
4:00 P.M.–5:00 P.M.	Presenters with Posters

Business and Luncheon Meetings

11:15 A.M.–12:15 P.M.	ASB Business Meeting, Russell House Theater
11:45 A.M.–1:15 P.M.	Beta Beta Beta Luncheon, Carolina Inn (Radisson)
12:30 P.M.–2:00 P.M.	Southeastern Chapter of the Ecological Society of America Luncheon, Carolina Inn (Radisson), ***Long-Term Ecological Research,*** presented by *Dr. James T. Callahan,* Associate Program Director of Ecosystem Studies, National Science Foundation.

Paper Sessions: Russell House

2:00 P.M.–5:15 P.M.	Plant Ecology, Session V, Room 305
1:30 P.M.–4:45 P.M.	Ichthyology/Herpetology, Session III, Room 203
2:30 P.M.–5:00 P.M.	Animal Ecology, Session I, Room 202
2:00 P.M.–4:45 P.M.	Aquatic Ecology, Session III, Room 303
2:15 P.M.–5:15 P.M.	Symposium, Russell House Theater, *Barrier Islands.* Co-sponsored by the Southeastern Chapter of the Ecological Society of America and ASB. Organized by Courtney Hackney.

ASB Banquet

6:00 P.M.–7:30 P.M.	Social Hour with Cash Bar, Carolina Inn (Radisson)
7:30 P.M.	ASB Banquet, Columbia Ballroom, Carolina Inn (Radisson)

SATURDAY, APRIL 12, 1986

8:00 A.M.	Executive Committee Meeting, Carolina Inn (Radisson)
8:00 A.M.	Beginning of Field Trips, Departures from Parking Lot of Carolina Inn (Radisson)

Thursday Morning General Session

AIR POLLUTION EFFECTS ON SOUTHEASTERN FORESTS

The plenary speaker for the 1986 General Session is *Dr. Ellis B. Cowling,* Professor of Plant Pathology and Associate Dean for Research in the School of Forest Resources at North Carolina State University.

Dr. Cowling is an internationally known authority on the ecological effects of airborne chemicals. He has published widely in several areas including the comparative biochemistry of wood decay, forest pathology, chemical climatology, and acid precipitation. His extensive training and expertise in plant pathology has led to his editorship of a five volume advanced *Treatise on Plant Disease* published by Academic Press.

Dr. Cowling's professional accomplishments are significant and varied. He has served as an elected member of the National Academy of Sciences since 1973 and was Vice-Chairman of the Board on Agriculture and Renewable Resources for the Academy from 1977–80. He is a Fellow of the International Academy of Wood Science and the American Phytopathological Society and has served on the Editorial Boards of *Phytopathology, Forest Science* and as Associate Editor for the *Annual Review* of *Phytopathology.* He is the recipient of awards through Sigma Xi, the *IX* International Congress of Plant Protection, and several state organizations within North Carolina. Dr. Cowling's pioneering efforts in assessing the possible effects of air pollution on vegetation led to his serving as Chairman of the National Atmospheric Deposition Program from 1975–83 and in a critical leadership capacity in the development of the National Acid Precipitation Assessment Program in the United States from 1978–81.

Dr. Cowling is uniquely qualified to deliver an important and topical address concerning the consequences of air pollution on our southeastern forests. The presentation is co-sponsored by ASB and the Southeastern Section of the Botanical Society of America.

ASB Paper & Poster Sessions and Symposia

THURSDAY MORNING, APRIL 10

Plant Ecology, Session I—Russell House Room 303

Presiding: *Dr. Jerry M. Baskin,* University of Kentucky

10:00 1. Niemeier, Sue E. (Johnson County Community College). Comparative growth and phenological response of five populations of *Crotalaria sagittalis* L. (Leguminosae).

10:15 2. Walker, Gary L. (University of Tennessee). Breeding systems and genetic variability in the population center and disjunct ranges of northern white cedar, *Thuja occidentalis.*

10:30 3. Wein, Gary R. and Steward T. A. Pickett. (Rutgers University). Dispersal, establishment and survivorship of a cohort of *Erythronium americanum* Ker.

10:45 4. Baskin, Jerry M., Hal D. Bryan, and Carol C. Baskin. (University of Kentucky and Kentucky Department of Transportation). Ecological life cycle of the rare plant species *Synandra hispidula:* A strict biennial.

11:00 5. Bender, Martin H. and Jerry M. Baskin. (University of Kentucky). Theoretical rates of increase in annual, biennial, and perennial plants: Effect of delayed reproduction in perennials.

11:15 6. Robertson, Judith L. and Robert Wyatt. (University of Georgia). Pollination ecology of the yellow fringed orchid in disjunct portions of its range in the southeastern United States.

11:30 7. Jolls, Claudia L. and Cynthia L. Hatley. (East Carolina University and University of Michigan Biological Station). Nectar content differences between the genders of the bladder-campion, *Silene vulgaris.*

11:45 8. McDearman, Will and Albert B. Pittman. (Mississippi Museum of Natural Science and Vanderbilt University). Staminate and pistillate spectral cues in *Zigadenus glabberrimus.*

Plant Ecology, Session II—Russell House Room 305

Presiding: *Dr. John E. Pinder,* Savannah River Ecology Laboratory

10:00 9. Hudson, Jarvis E. (Fayetteville State University). Ten years of change in an Appalachian oak forest.

10:15 10. Shotola, Steven J., George T. Weaver, and William C. Ashby. (Southern Illinois University). Structural and compositional changes from 1957 to 1985 on two abandoned fields in southwestern Illinois.

10:30 11. Smallidge, P. J., J. E. Pinder, and F. B. Golley. (Savannah River Ecology Laboratory). An anomalous secondary successional pattern in a South Carolina old field.

10:45 Break

11:00 12. Anderson, Loran C. (Florida State University). Hurricane effects on Apalachicola (Florida) barrier island vegetation.

11:15 13. Collins, B. S. and S. T. A. Pickett. (Savannah River Ecology Laboratory and Rutgers University). Influences of experimental canopy gaps on the dynamics of herb layer species in a northern hardwoods forest.

11:30 14. Hupp, Cliff R. (U.S. Geological Survey). Woody vegetation and bank processes along modified west Tennessee streams.

Plant Systematics, Session I—Russell House Room 332

Presiding: *Dr. James W. Hardin,* North Carolina State University

10:00 15. Pittman, Albert B. (Vanderbilt University). Systematic studies of intraspecific variation in *Scutellaria saxatilis* Riddell.

10:15 16. Bounds, Richard R. (North Carolina State University). Numerical taxonomic studies of *Rhexia* spp.

10:30 17. Hollowell, Victoria C. and Thomas R. Soderstrom. (University of South Carolina and Smithsonian Institution). Generic constraints within the subtribe Parianinae (Poaceae: Bambusoideae: Olyreae).

10:45 18. Hardin, James W. and Lois H. Garner. (North Carolina State University). Autochory in *Illicium.*

11:00 19. Siwundla, Nompembelelo and Jon Stucky. (North Carolina State University). Systematic anatomy of leaves, cotyledons and pericarps in *Sesbania* of the southeastern United States.

11:15 20. Haynes, Robert R. (University of Alabama). A revision of *Hydrocleys* (Limnocharitaceae).

11:30 21. Jones, Ronald L. (Eastern Kentucky University). The distribution of *Aster georgianus* Alexander in the Carolinas.

Aquatic Ecology, Session I—Russell House Room 327

Presiding: *Dr. Richard J. Neves,* Virginia Polytechnic University

10:00 22. Stokes, Glenn D. and William S. Birkhead. (Columbus College). pH as an isolating mechanism for two Cyprinid fish.

10:15 23. Birkhead, William S., George E. Stanton, and Glenn D. Stokes. (Columbus College). Fishes of the Upatoi Creek drainage, westcentral Georgia.

10:30 24. Layzer, James B. and Michael D. Clady. (Tennessee Cooperative Fishery Research Unit and Oklahoma Cooperative Fish and Wildlife Research Unit). Phenotypic variation of young-of-year bluegills (*Lepomis macrochirus*) among microhabitats.

10:45 25. Simonson, Timothy D. and Richard J. Neves. (Virginia Cooperative Fish and Wildlife Research Unit, Virginia Polytechnic Institute and State University). Distribution, abundance and habitat of the orangefin madtom in Virginia and North Carolina.

11:00 26. Moore, Christopher M. and Richard J. Neves. (Virginia Cooperative Fish and Wildlife Research Unit, Virginia Polytechnic Institute and State University). Food resource partitioning among coexisting predators in Smith Mountain Lake, Virginia.

11:15 27. May, Roderick L. and R. Don Estes. (Tennessee Cooperative Fishery Research Unit). An age and growth study of paddlefish (*Polydon spathula*) in three subimpoundments in northwestern Tennessee.

11:30 28. Feeman, Joe C. (Tennessee Valley Authority). The effect of physical alterations on the fish fauna of Coal Creek, Anderson County, Tennessee.

11:45 29. Meffe, Gary K. (Savannah River Ecology Laboratory). Variation in mosquitofish embryo size: Population and individual effects.

Cytology/Genetics, Session I—Russell House Room 203

Presiding: *Dr. Charles Biggers,* Memphis State University

10:00 30. Reynolds, John D., William V. Dashek, and Gerald C. Llewellyn. (Virginia Commonwealth University, Atlanta University, and Virginia Department of Health). A bioassay for mycotoxins using the water fern, *Marsilea quadrifolia.*

10:15 31. Orvos, David R., Cletus M. Sellers, Jr., and Norman E. Garrison (James Madison University). Optimization of an isolation buffer system for rainbow trout (*Salmo gairdneri*) liver.

10:30 32. Ashley, Terry. (University of Tennessee). G-band position effects on meiotic synapsis and crossing over.

10:45 33. Finlay, Mary Fleming, Dawn Anderson, and Angela Reid. (Benedict College). Genetic variation and interaction of intestinal enzymes in the mouse.

11:00 34. Murdy, William H. and M. Eloise Brown Carter. (Emory University). Variable expression of duplicate genes in *Talinum calcaricum* Ware.

Parasitology/Microbiology, Session I—Russell House Room 202

Presiding: *Dr. Burton J. Bogitsh,* Vanderbilt University

10:00 35. Bogitsh, Burton J. and K. F. Kirschner. (Vanderbilt University). Further ultrastructural studies on hemoglobinase activity in *Schistosoma japonicum.*

10:15 36. Johnson, Sandra Strawbridge, Sharon Patton, Jim Jensen, and Robert M. Finch. (University of Tennessee). Survey of animals at the Knoxville Zoological Park for antibodies to *Toxoplasma gondii.*

10:30 37. Evans, Thomas E., Jr. and Grover C. Miller. (North Carolina State University). Scanning electron microscopy of *Schistosoma mansoni* adults from unisexual and bisexual infections.

10:45 38. Patton, Sharon, Alan R. Rabinowitz, and Sandra Strawbridge Johnson. (University of Tennessee and Bronx Zoo). A coprological survey of parasites of wild neotropical Felidae.

11:00 39. Scott, Edgar L., III, Robert B. Jeppsen, and M. Gunasekaran. (Fisk University). Lipid analysis of *Tilletia controversa.*

11:15 40. Hobden, Jeffery A. and J. M. Upadhyay. (Loyola University). Isolation of thermophilic and thermotolerant geofungi from the Yucatan Peninsula, Mexico.

11:30 41. Sambandam, T. and M. Gunasekaran. (Fisk University). Partial purification and properties of phosphorylase from *Phymatotrichum omnivorum.*

11:45 42. Perry, James W. (Frostburg State College). Ultrastructural aspects of *Monotropa uniflora:* Ectomycorrhiza and phloem.

THURSDAY AFTERNOON, APRIL 10

Symposium—Russell House Theater
Blackwater River Ecosystems

Co-sponsored by the Southeastern Chapter of the Ecological Society of America and the Association of Southeastern Biologists.

Presiding: *Dr. Richard T. Edwards,* University of Georgia

1:00 Chairperson's remarks

1:05 43. Smock, Leonard A. (Virginia Commonwealth University). Southeastern USA blackwater river systems—an overview.

1:23 44. Noltemeier, Debra D., M. M. Brinson, Don Holbert, and Martha N. Jones. (East Carolina University). Variation in water chemistry in blackwater streams in the Coastal Plain of North Carolina.

1:41 45. Blood, Elizabeth R. (University of South Carolina). Biogeochemistry of blackwater Coastal Plain streams.

1:59 46. Smith, Garrett W. and D. A. McClary. (University of South Carolina, Aiken). The importance of ammonification in N-cycling at blackwater sites.

2:17 47. English, William R. (Clemson University). Relationships between habitat type and aquatic invertebrate community structure.

2:35 Break

2:45 48. Stites, David L. and A. C. Benke. (University of Alabama). Estimates of chironomid growth and productivity in a blackwater river.

3:03 49. Cuffney, Thomas F. (University of Georgia). Riparian flooding and the processing and exchange of organic matter in Coastal Plain streams.

3:21 50. Carlough, Leslie A. (University of Georgia). Protozoa in two southeastern blackwater rivers: Possible trophic significance.

3:39 51. Edwards, Richard T. and J. L. Meyer. (University of Georgia). Metabolism of a sixth order blackwater river in southeastern Georgia.

Ichthyology and Herpetology, Session I—Russell House Room 203

Presiding: *Dr. Ronald Altig,* Mississippi State University

1:30 52. Ireland, Patrick H. (Radford University). Egg deposition, larval growth, and survivorship in spotted salamander (*Ambystoma maculatum*) populations.

1:45 53. Asquith, Adam. (Mississippi State University). Variation in the mating call of the green treefrog, *Hyla cinerea.*

2:00 54. Thibaudeau, D. Giselle and Ronald Altig. (Mississippi State University). Developmental sequences of development and atrophy of oral structures in anuran tadpoles.

2:15 55. Blackwell, Jeanne L. and Adam Asquith. (Mississippi State University). Feeding and assimilation efficiencies involving sixteen species of amphibians.

2:30 56. Bonner, Lisa A. and Ronald Altig. (Mississippi State University). Environmental predictability and amphibian breeding ecology.

2.45 57. Schorr, Mark S. and Ronald Altig. (Mississippi State University). Ontogenetic acquisition of enteric protozoans by amphibian larvae.

3:00 Break

3:15 58. Carver, Wayne E. and Roger H. Sawyer. (University of South Carolina). Localization of Alpha and Beta Keratins in Reptiles.

3:30 59. Dodd, C. Kenneth, Jr. (U.S. Fish and Wildlife Service). Movements and habitat use by the flattened musk turtle, *Sternotherus depressus.*

3:45 60. Dodd, C. Kenneth, Jr. (U.S. Fish and Wildlife Service). Basking in the flattened musk turtle, *Sternotherus depressus.*

4:00 61. Marion, Ken R., Flora M. Love, William A. Cox, and Carl H. Ernst. (University of Alabama at Birmingham, Marion Military Institute, and George Mason University). Food habits of the flattened musk turtle, *Sternotherus depressus.*

4:15 62. Stuart, Michael D. and Grover C. Miller. (North Carolina State University). The ecology of the eastern box turtle, *Terrapene c. carolina,* (Chelonia: Emydidae) in North Carolina.

4:30 63. Gibbons, J. Whitfield. (Savannah River Ecology Laboratory). Revelations of longterm research on long-lived turtles.

Animal Physiology, Session I—Russell House Room 202

Presiding: *Dr. Dan R. Varney,* Eastern Kentucky University

1:30 64. Claiborne, James B. (Georgia Southern College). Acid-base regulation in marine teleosts: A limitation of euryhalinity?

1:45 65. Kormanik, Gregg A. (University of North Carolina, Asheville). Uterine conditions and acid-base status of prenatal pups of the dogfish, *Squalus acanthias.*

2:00 66. Young, Carolyn S. and John W. Harris. (Tennessee Technological University). The effects of temperature stress on isozyme banding patterns in channel catfish, *Ictalurus punctatus* (Rafinesque).

2:15 67. Hinton, T. G., F. W. Whicker, and J. E. Pinder, III. (Savannah River Ecology Laboratory and Colorado State University). Temperature effects on the kinetics of radium and strontium in pond sliders.

2:30 Break

2:45 68. DeCoursey, Patricia J. (University of South Carolina). Circadian photoentrainment: Photic thresholds for phase-shifting relative to habitat for 4 species of nocturnal rodents.

3:00 69. Varney, Dan R., Michael Ndefru, Sanford L. Jones, Malcolm R. Siegel, and Panlos Zavos. (Eastern Kentucky University and University of Kentucky). The effect of fescue endophyte on the rat estruous cycle.

3:15 70. Hem-Lee, Hugh C. and Dan R. Varney. (Eastern Kentucky University). Physiological effects of tall fescue toxicity on mammalian internal organs.

3:30 71. Kappes, Carl J., Dan R. Varney, Sanford L. Jones, Malcoln R. Siegel, and Panlos Zavos. (Eastern Kentucky University and University of Kentucky). Reproduction and lactation in laboratory rats fed endophyte-infected fescue seed.

3:45 72. Morton, David and Hugh Hall. (Frostburg State College and Wright State University). Blood urea levels and urease positive Enterobacteriaceae in the common vampire bat (*Desmodus rotundus*).

Plant Ecology, Session III—Russell House Room 327

Presiding: *Dr. Edward E. C. Clebsch,* University of Tennessee

1:00 73. Peet, Robert K. and Norman L. Christensen. (University of North Carolina and Duke University). Hardwood forests of the North Carolina Piedmont: Variation in space and time.

1:15 74. Greller, Andrew M. (Queens College, CUNY). Critical physiognomic attributes of forest zones in eastern North America.

1:30 75. Jones, Steven M., Richard K. Meyers, and Robert Zahner. (Clemson University). A physiographic classification of forest lands of South Carolina.

1:45 76. Methven, Andrew S. (University of Tennessee, Knoxville). The fungus flora of Highlands, North Carolina and vicinity.

2:00 77. Bian, Ling. (University of Georgia). Modeling vegetation-climate relationships in China.

2:15 78. Box, Elgene O. (University of Georgia). Vegetation science in east Asia and the southeastern USA.

2:30 79. Fujiwara, Kazue. (Yokohama National University). Potential and actual vegetation regions in Japan.

2:45 Break

3:00 80. Fralish, James S. (Southern Illinois University, Carbondale). A site-specific approach for predicting potential stand composition in the Shawnee Hills Forest of Illinois.

3:15 81. Adams, Harold S. and Steven L. Stephenson. (Dabney S. Lancaster Community College and Fairmont State College). Ecological study of old-growth red spruce stands in the mid-Appalachians.

3:30 82. Clebsch, Edward E. C. and Gary L. Walker. (University of Tennessee, Knoxville). Recent discoveries of range extensions of vascular plants associated with disjunct arbor vitae (*Thuja occidentalis* L.) in the southeast.

3:45 83. Smith, Mary M. (Clemson University). A floristic study of Palmetto Islands Co. Park, Charleston Co., S.C.

4:00 84. Parr, Patricia Dreyer and Rhonda K. Jones. (Oak Ridge National Laboratory and Fort Valley State College). Initiation of long-term research on a rare plant population on the Oak Ridge National Environmental Research Park.

Forum for Herbarium Curators—Russell House Room 303

4:00– 85. Massey, Jim, Cindy Aulbach-Smith, Jim Matthews, and Jim Doyle. (University of North

5:00 Carolina-Chapel Hill, University of South Carolina, University of North Carolina-Charlotte, and Thomas Aquinas College). A forum for herbarium curators and users: "Computers in the Herbarium."

FRIDAY MORNING, APRIL 11

Invertebrate Zoology, Session I—Russell House Room 305

Presiding: *Dr. Frederick W. Harrison,* Western Carolina University

8:30 86. Harrison, Frederick W., Nancy W. Kaye, and Gordon I. Kaye. (Western Carolina University and Albany Medical College). The "dermal membrane" of the freshwater sponge, *Eunapius fragilis* (Leidy 1851).

8:45 87. Harrison, Frederick W. and Barry G. Warner. (Western Carolina University and University of Waterloo). Fossil freshwater sponges from western Canada: An overlooked group of Quaternary paleoecological indicators.

9:00 88. Tao, Ma Yun and Frederick W. Harrison. (Western Carolina University). Cytochemical examination of oocyte development in freshwater sponges.

9:15 89. Bisbee, John W., John C. Francis, and Frederick W. Harrison. (Lenoir-Rhyne College, University of New Orleans, and Western Carolina University). Development of freshwater sponges from reduction bodies grown in culture.

9:30 90. Smith, J. David. (Western Carolina University). Cellular responses to BSA-FITC and wound healing in the body wall of the slug, *Deroceras laeve.*

9:45 Break

10:00 91. Hanley, Robert W. (RMT, Inc.). Biogeography and distribution of the Pleuroceridae (Mollusca: Gastropoda) in the Warrior River Basin, Alabama.

10:15 92. Heard, William H. (Florida State University). Brooding patterns in freshwater mussels.

10:30 93. Chase, Kimberly A. and Ronald Altig. (Mississippi State University). Breeding ecology of the green lynx spider (*Peucetia viridans*).

10:45 94. Oetinger, Liyonabah and Ronald Altig. (Mississippi State University). Spots on moth wings: Their positions and possible functions.

Aquatic Ecology, Session II—Russell House Room 202

Presiding: *Dr. Donald C. Tarter,* Marshall University

8:30 95. Connell, Mary U. and Robin L. Canterbury. (Appalachian State University). Nutrient loading and its effect on the composition and structure of the benthic algal community in the South Fork of the New River.

8:45 96. De La Cruz, A. A., C. T. Hackney, and N. Bhardwaj. (Mississippi State University, University of North Carolina at Wilmington, and University of Rajasthan). Temporal and spatial patterns of redox potential (EH) in three tidal marsh communities.

9:00 97. Di Stefano, Robert J., Mark C. Lewis, Richard J. Neves, and Louis A. Helfrich. (Virginia Polytechnic and University of Kentucky). Effects of acute acid exposure to a species of freshwater crayfish.

9:15 98. Bowling, J. W., J. J. Alberts, R. A. Geiger, D. W. Lutkenhoff, and J. E. Pinder. (Savannah River Ecology Laboratory). Does the annual cycle of Cs-137 concentrations in lake waters result in an annual cycle of concentrations in largemouth bass, *Micropterus salmoides*?

9:30 99. Kelly, Mary Sauls. (Savannah River Ecology Laboratory). Concentrations of cesium-137 in young bass and sediments: Effects of body size and location on bioaccumulation.

9:45 Break

10:00 100. Malcomb, C. Dale, Randy D. Taylor, and Donald C. Tarter. (Marshall University). The use of STORET and the National Sanitation Foundation's water quality index to develop a regionally adaptable index of water quality.

10:15 101. Meadows, James A. and Donald C. Tarter. (Marshall University). Ecological assessment of benthic macroinvertebrates in the Cranberry River, Pocahontas County, West Virginia.

10:30 102. Pettry, Daniel K. and Donald C. Tarter. (Marshall University). Ecological life history of the mayfly *Baetisca carolina* Traver in a West Virginia stream.

10:45 103. Adkins, M. D., D. A. Schmidt, and D. C. Tarter. (Marshall University). Free fatty acids and lipid content of first and second year naiads of the stonefly *Acroneuria carolinenis* (Banks).

Teaching, Session I—Russell House Room 303

Presiding: *Dr. J. Kenneth Shull,* Appalachian State University

9:45 104. Wynne, Joe and Stephen G. Boyce. (Duke University). Dynamo: A computer language which makes population dynamics simulation possible in the classroom.

10:00 105. Shull, J. Kenneth. (Appalachian State University). The treatment of "unexpected" data in the genetics teaching laboratory.

10:15 106. Creek, Robert. (Eastern Kentucky University). An individualized approach to teaching a plant physiology laboratory.

10:30 107. Varney, Dan R., Judith Cunningham, and Juanita Cox. (Eastern Kentucky University and Madison County Schools). Using readability scales in evaluating science texts.

Plant Systematics, Session II—Russell House Room 332

Presiding: *Dr. Robert Beckmann,* North Carolina State University

9:45 108. Beckmann, Robert L. (North Carolina State University). Flavonoids of the white ash (*Fraxinus americana* L.) polyploid complex.

10:00 109. Moore, Michael O. (University of Georgia). A systematic study of selected *Vitis* taxa in the southeastern United States.

10:15 110. Johnson, Robert and James W. Wallace, Jr. (Western Carolina University). The flavonoid profile of *Cymophyllus fraseri* (Andrews) Mackenzie (Cyperaceae).

10:30 111. Kemp, Andrew C. and William H. Murdy. (Emory University). An electrophoretic study of the GOT enzyme system in *Talinum mengesii.*

Plant Ecology, Session IV—Russell House Room 327

Presiding: *Dr. Rebecca Sharitz,* Savannah River Ecology Laboratory

9:45 112. Day, Frank P. (Old Dominion University). Effects of flooding and nutrient enrichment on biomass allocation in red maple seedlings.

10:00 113. Keever, Catherine and Rebecca Sharitz. (Millersville University of Pennsylvania and Savannah River Ecology Laboratory). Effects of geographic location on growth forms of *Heterotheca latifolia* Buckl. and *Heterotheca subaxillaris* (Lam.) Britt. & Rusby.

10:15 114. Robertson, Philip A. (Southern Illinois University). Tree growth on a lowland site, Union County, Illinois.

10:30 115. Horn, Charles N. (University of Alabama). Adaptation to the aquatic environment by species of *Heteranthera.*

10:45 116. Ware, Stewart. (College of William and Mary). Substrate adaptation in rock outcrop plants of the Ozarks.

Ichthyology and Herpetology, Session II—Russell House Room 203

Presiding: *Dr. R. Don Estes,* Tennessee Cooperative Fishery Research Unit

10:00 117. Maddock, Michael B. and Frank J. Schwartz. (University of North Carolina). Cytotaxonomic studies of the elasmobranchs.

10:15 118. Schmid, Thomas H. and F. F. Snelson, Jr. (University of Central Florida). Spine growth and regeneration in the Atlantic stingray.

10:30 119. Gobalet, Kenneth W. (Loyola University of New Orleans). Analysis of fish remains from archaeological site CA-Mnt-220, Elkhorn Slough, Monterey County, California indicates major recent habitat disruption.

10:45 120. Menhinick, Edward F. (University of North Carolina at Charlotte). Production of fish illustrations.

FRIDAY AFTERNOON, APRIL 11

Poster Session—Russell House Room 203 Alcove

10:00–5:00 Posters on Display

4:00–5:00 Presenters with Posters.

121. Bassin, Dennis M. (University of South Carolina). Constraints and considerations in teaching field biology to orthopedically handicapped college students.

122. Bauman, Thomas R., Jolanta M. Wilman, and Earle A. Cross. (University of Alabama). Observations on eclosion of the mud-dauber wasp, *Trypoxylon politum.*

123. Bonner, Meta. (North Carolina State University). Puberty onset in golden hamsters prenatally exposed to phenobarbital.

124. Dindo, John J. and Ken R. Marion. (Dauphin Island Sea Lab and University of Alabama at Birmingham). Initial observations on an Alabama coastal heronry.

125. McCormick, J. Frank. (University of Tennessee). International training in natural resource management.

126. Rohde, Fred C. and Rudolf G. Arndt. (North Carolina Division of Marine Fisheries, and Stockton State College). Two new *Elassoma* from the Carolinas.

127. Stephenson, Steven L. (Fairmont State College). Distribution and ecology of Myxomycetes in southern Appalachian spruce-fir forest.

128. White, David A. (Loyola University of New Orleans). Sedimentation and plant colonization on two inner deltaic splays within the lower Mississippi River Delta.

Plant Ecology, Session V—Russell House Room 305

Presiding: *Dr. Frank P. Day,* Old Dominion University

2:00 129. White, David A. and Michael J. Simmons. (Loyola University of New Orleans). Phenology and primary productivity within the marshes of the lower Pearl River Basin, Louisiana.

2:15 130. Pinder, J. E., III, and T. A. Christiansen. (Savannah River Ecology Laboratory). The effects of residual fertilizers on the productivity of plant communities in secondary succession.

2:30 131. Megonigal, J. Patrick and Frank P. Day. (Old Dominion University). Models of organic matter dynamics in the Great Dismal Swamp, Virginia.

2:45 132. West, Susan K. and Frank P. Day. (Old Dominion University). Estimates of fine biomass in four communities within the Great Dismal Swamp.

3:00 133. Tupacz, Edward G. and Frank P. Day. (Old Dominion University). Root decomposition in the seasonally flooded Great Dismal Swamp.

3:15 134. Harker, Anne C., Cory W. Berish, and Harvey L. Ragsdale. (Emory University). The role of black locust (*Robinia pseudoacacia*) in root dynamics of regenerating southern Appalachian forests.

3:30 Break

3:45 135. Schmalzer, Paul A. and C. Ross Hinkle. (The Bionetics Corporation and John F. Kennedy Space Center). Biomass, nutrient concentrations and nutrient standing crops in different age stands of oak scrub vegetation on John F. Kennedy Space Center, Florida.

4:00 136. Potter, Christopher S. and Harvey L. Ragsdale. (Emory University). Acid deposition interactions with a southern Appalachian forest canopy at the Coweeta Hydrologic Laboratory.

4:15 137. Winstead, Joe E. and John T. Riley. (Western Kentucky University). Latitudinal variation of sulfur in wood of *Carpinus caroliniana* and relationship to anthropogenic sulfur deposition.

4:30 138. Ward, Deanna, Peter Nielsen, and Dean Cocking. (James Madison University). Bioaccumulation of mercury in flood plain forest trees along the South River at Waynesboro, VA.

4:45 139. Luvall, Jeffrey C. and James E. Anderson. (National Space Technology Laboratory). Thermal infrared energy processes in western coniferous forest canopies.

5:00 140. Woods, F. W. and M. Hughes. (University of Tennessee). Wood density of three oak species in east Tennessee: 1940–45 and 1970–75.

Ichthyology and Herpetology, Session III—Russell House Room 203

Presiding: *Dr. David G. Lindquist,* University of North Carolina at Wilmington

1:30 141. Heins, David C. and John A. Baker. (Tulane University and U.S. Army Corps of Engineers). Natural history of *Percina vigil* Hay in the Homochitto River, Mississippi.

1:45 142. Pierson, J. Malcolm. (Alabama Power Company). Distribution and status of rare fishes in the lower Cahaba River, Alabama.

2:00 143. Rohde, Fred C. and Steve W. Ross. (North Carolina Division of Marine Fisheries, and North Carolina State University). Life history of the swampfish, *Chologaster cornuta,* with comments on morphological changes.

2:15 144. Peterson, Mark S. (University of Southern Mississippi). Use of peripheral oligohaline marshes by centrarchids: Intrafamilial properties of osmotic adaptation.

2:30 145. Secor, David H., John Mark Dean, and P. W. Haake. (University of South Carolina). Somatic-otolith growth comparisons in larval and juvenile striped bass and spot.

2:45 146. Schwartz, Frank J. and Brenth K. Conway. (University of North Carolina). Age-growth, body-organ weight, and length-weight relationships for the sciaenid, *Stellifer lanceolatus,* from estuarine Cape Fear River, North Carolina.

3:00 Break

3:15 147. Middendorf, George A. and Bela J. Demeter. (Howard University and National Zoological Park). Behavioral interactions of the Chinese water dragon (*Physignathus cocincinus*).

3:30 148. Howe, Jeffrey C. and David G. Lindquist. (University of North Carolina at Wilmington). Efficacy of midwater fish aggregating devices (FADs) placed near two piers at Wrightsville Beach, NC in attracting coastal fishes.

3:45 149. Stephan, C. Diannne and David G. Lindquist. (University of North Carolina at Wilmington). An evaluation of midwater vs. benthic structures as fish aggregators.

4:00 150. Lawrence, Colleen M. and David G. Lindquist. (University of North Carolina at Wilmington). A comparison of fishes associated with an old and a new ship wreck.

4:15 151. Pottern, Gerald B. (North Carolina State University). Status of the Cape Fear shiner *Notropis mekistocholas* and its species-rich minnow community in a developing watershed.

4:30 152. Maurakis, E. G., W. S. Woolcott, R. E. Jenkins, R. W. Watson, and A. F. Horne. (George Washington University, University of Richmond, Roanoke College, United States Army, and Colorado State University). Factors affecting the distribution of fishes in the Rappahannock River, Virginia.

4:45 153. Maurakis, Eugene G. and Jules J. Loos. (George Washington University and Potomac Electric Power Company). Spawning of *Hybopsis rubrifrons* and *Notropis lutipinnis* over a *Nocomis leptocephalus* nest.

Animal Ecology, Session I—Russell House Room 202

Presiding: *Dr. Whitfield Gibbons,* Savannah River Ecology Laboratory

2:30 154. Menon, Shaily A. (University of South Carolina). Photoentrainment of activity rhythms of nocturnal rodents in an artificial den recording system.

2:45 155. Barry, Ronald E. and Thomas E. Baumner. (Frostburg State College). Spatial relationships of locally sympatric, woodland *Peromyscus* in western Maryland.

3:00 156. Jackson, Jerome A. (Mississippi State University). Habitat predictors of present and future status of red-cockaded woodpecker colonies.

3:15 157. Luukkonen, David R., James D. Fraser, and Dean F. Stauffer. (Virginia Polytechnic Institute and State University). Loggerhead shrike nesting success in Virginia.

3:30 158. Frazer, Nat B. (Mercer University). Survival from egg to adulthood in a declining population of loggerhead turtles, *Caretta caretta.*

3:45 Break

4:00 159. Semlitsch, Raymond D. (Duke University). Costs of predator avoidance in larval salamanders.

4:15 160. Bassin, Dennis M. (University of South Carolina). Temporal and spatial relationships in feeding patterns of larval spot, *Leiostomus xanthurus.*

4:30 161. Hayes, Robert, Peter Nielsen, and Dean Cocking. (James Madison University). Bioaccumulation of mercury by earthworms in South River flood plain soils at Waynesboro, VA.

4:45 162. Pinder, J. E., III, and P. R. Jackson. (Savannah River Ecology Laboratory and Paine College). Orthopteran grazing on plants with different photosynthetic pathways.

Aquatic Ecology, Session III—Russell House Room 303

Presiding: *Dr. Elizabeth Blood,* Baruch Institute Field Laboratory

2:00 163. Mahoney, Diane L. and Barbara E. Taylor. (Savannah River Ecology Laboratory). Emergence from resting stages and succession of zooplankton in a Carolina Bay.

2:15 164. Watson, Charles N. (East Tennessee State University). The use of pupal exuviae to compare chironomid communities of a lake and a fishless pond.

2:30 165. Johnson, Dan M. (East Tennessee State University). The life history of *Tetragoneuria cynosura* (Odonata: Corduliidae) in Bays Mountain Lake.

2:45 166. Stark, Gregory J. and James B. Layzer. (Tennessee Cooperative Fishery Research Unit, and the Center for the Management, Utilization and Protection of Water Resources). Spatial distribution of crayfish in Mill Creek, Davidson County, Tennessee.

3:00 167. Hackney, Courtney T. (University of North Carolina at Wilmington). A note on the effects of abnormally low temperature on the Carolina marsh clam.

3:15 168. Naimo, Teresa J. and Andrew C. Miller. (Tennessee Cooperative Fishery Research Unit and Waterways Experiment Station). Burrowing activities of three species of gravel bar mussels.

3:30 Break

3:45 169. Richardson, Terry D. and Marsha Stock. (University of Alabama). The differential occurrence of an epizoic red alga on the stream snails, *Elimia clara* and *E. cahawbensis.*

4:00 170. Shaffer, Gary P. and Peter Cahoon. (Louisiana State University and University of British Columbia). Extracting information from ecosystems containing high spatial and temporal variability: Benthic microfloral productivity.

4:15 171. Barclay, Lee A., Jr. (Tennessee Technological University and U.S. Fish and Wildlife Service). Comparative importance of snag habitat for animal production in Coastal Plain and Cumberland Plateau streams.

4:30 172. Patterson, Samuel G. and J. Frank McCormick. (University of Virginia and University of Tennessee). Mangrove community boundary interpretation and detection of areal changes on Marco Island, FL.

Symposium—Russell House Theater
Barrier Islands of Southeastern United States

Co-sponsored by the Southeastern Chapter of the Ecological Society of America and the Association of Southeastern Biologists.

Presiding: *Dr. Paul E. Hosier,* University of North Carolina at Wilmington

2:15 173. Hosier, Paul E. (University of North Carolina at Wilmington). Introduction to barrier island symposium.

2:20 174. Nummedal, Dag. (Louisiana State University). Holocene history, morphology and hurricane response of Gulf Coast barrier islands.

2:47 175. Cleary, William J. (Department of Earth Sciences, University of North Carolina at Wilmington). Holocene History and Morphology of Atlantic Barrier Islands: Virginia–Georgia.

3:14 176. Eleuterius, Lionel N. (Gulf Coast Research Laboratory). Botanical aspects of the Gulf coastal region.

3:41 177. Bratton, Susan. (University of Georgia). Disturbance dynamics of maritime forests.

4:08 178. Turner, Monica. (University of Georgia). Effects of multiple disturbances on barrier island saltmarshes.

4:35 179. Godfrey, P. J. (University of Massachusetts). Comparative ecology of Bahamian and southeastern U.S. beaches.

5:02 180. Symposium Summary and Discussion.

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Abstracts

1

Niemeier, Sue E. Johnson County Community College--Comparative growth and phenological response of five populations of Crotalaria sagittalis L. (Leguminosae). Because of the diverse habitats the species occupies, a study was initiated to determine if genetically based differences exist in C. sagittalis populations and whether these are of adaptive significance. Populations from Iowa, Illinois, South Carolina, Louisiana, and Vera Cruz, Mexico were compared for growth and phenological response under varying temperatures and photoperiods. In greenhouse conditions, plants from Iowa and Illinois populations exhibited more rapid growth and lower average heights than plants from South Carolina, Louisiana and Mexico. Although C. sagittalis is a day neutral species, populations from Iowa and Illinois were always first to flower, those from South Carolina and Louisiana intermediate, and those from Mexico last. Data from growth chamber studies indicated that latitude of origin, daylength and temperature influenced maximum plant height. The more northern populations were earliest to attain their maximum height while southern populations were latest. Flowering response was similar to that observed in greenhouse conditions. Growth and flowering was greatly reduced in cool temperature conditions. Results of these studies revealed differences in growth and phenology between northern and southern populations. These characteristics may enable northern populations to develop and reproduce as rapidly in cooler climates with a shorter growing season as do plants of southern populations at warmer temperatures. Survival of a species is dependent on its ability to coordinate its life cycle with periodic activity in the environment. This ability was demonstrated in populations of C. sagittalis and may account for the species wide distribution.

2

WALKER, GARY L. University of Tennessee--Breeding systems and genetic variability in the population center and disjunct ranges of northern white cedar, Thuja occidentalis.

Northern white cedar (Thuja occidentalis L.) is a native conifer of North America, known to horticulturists as arbor vitae. The population center of this species is in eastern Canada where it is an important commercial timber species. In addition to the main range surrounding the Great Lakes region there are disjunct ranges of this species from southern New England southward through the ridge and valley of the Appalachian mountains into Tennessee, and in south central Ohio. Leaf tissue samples collected from stands of white cedar across the population center and in the southern disjunct ranges were analyzed using starch gel electrophoretic techniques to examine allozyme variability in these populations. Results demonstrate the existance of highly variable genotypes within and between stands. Stands were observed to be reproducing sexually, asexually, and in a combination of these reproductive modes. Populations with non-random spatial distributions of genotypes were described by three variable allozyme systems (LAP, PGM, and MDH). These data show possible asexual clustering of alleles into genets effectively preserving genetic variability in these populations.

3

WEIN, GARY R. and STEWARD T. A. PICKETT. Rutgers University--Dispersal, establishment, and survivorship of a cohort of Erythronium americanum Ker. Approximately 40% of 500 Erythronium americanum seeds sown in a one m^2 seedplot exclosure in 1979 in a black oak-beech forest in New Jersey germinated. This cohort exhibited a type II Deevey survivorship curve between 1980-1983. A few seeds of Erythronium americanum remain dormant longer than 1-yr. Seed exclosure experiments indicate that seeds protected from seed dispersal and predators will germinate at the location on which they are released from the parent plant. Vegetative reproduction in the 1979 cohort was observed during 1981. Plants which reproduced vegetatively were slightly larger than those that did not. Size-class appears to be a better measure of population structure in this woodland herb than is age.

4

BASKIN, JERRY M.,[1] HAL D. BRYAN,[2] and CAROL C. BASKIN.[1] University of Kentucky[1] and Kentucky Department of Transportation[2]--Ecological life cycle of the rare plant species Synandra hispidula: A strict biennial. Synandra hispidula (Michx.) Britt. has been reported to be an annual, a winter annual, a biennial and a perennial. Our observations on its life cyle in Kentucky show that it is a strict biennial. Seeds germinate in late winter and early spring, and all surviving plants flower and produce seeds the second spring, after which the entire plant dies. The ecological life cycles of strict vs. facultative biennials (monocarpic perennials or "biennials") will be discussed.

5

BENDER, MARTIN E. and JERRY M. BASKIN. University of Kentucky--Theoretical rates of increase in annual, biennial, and perennial plants: Effect of delayed reproduction in perennials.
When fitness is defined as population growth rate and it is assumed that populations increase indefinitely, the most fit plant species in a particular habitat is the one with the life history that results in the greatest rate of increase. This statement can be rephrased by considering an annual, a biennial, and a perennial with equal rates of increase. That is, the species with the life history that can achieve a rate of increase equal to that of the other two by producing the fewest seeds obviously has the advantage. Using this approach, R. Hart (Am. Nat. 111: 792-799, 1977) showed that for annuals and biennials to have the same rate of increase as perennials, annuals must produce as many, or for some survivorship schedules more, seeds than perennials and that regardless of survivorship schedule biennials must always produce more seeds than perennials. Perennials have this advantage in Hart's models because she assumed that they produce seeds in their first year, which generally is not the case in nature. By assuming that perennials delay reproduction, it is shown that over a wide range of survivorship schedules annuals and biennials can achieve a rate of increase equal to that of perennials by producing fewer seeds.

6

ROBERTSON, JUDITH L. and ROBERT WYATT. University of Georgia--Pollination ecology of the yellow fringed orchid in disjunct portions of its range in the southeastern United States.
Platanthera ciliaris, the yellow fringed orchid, occurs in the Mountains and Coastal Plain of the southeastern United States but seldom in the intervening Piedmont province. Representative Mountain and Coastal Plain populations in the Carolinas were studied in 1983 and 1984 to compare pollinators, morphology, demography, and nectar production between sites. In both sites the pollinators were large butterflies, but the primary species differed markedly between sites. In the Mountains the primary pollinator was Papilio troilus and secondary pollinators included P. glaucus and Battus philenor. Coastal Plain pollinators were primarily Papilio palamedes, secondarily Phoebis sennae, and rarely, Papilio troilus. In addition, in the Coastal Plain site only, Tersa sphinxmoths were observed gathering nectar but did not pollinate P. ciliaris. Nine plant-level morphological characters and six flower-level characters were measured for randomly selected plants in each site. Morphological differences were detected primarily in flower-level characters which might be expected to reflect coevolution with or adaptation to pollinators. Plants flowered throughout August in the Mountains and from late August through mid-September in the Coastal Plain. Only about 20% of those individuals which flowered in 1983 flowered again in 1984. Nectar production was highly variable but continued in undisturbed flowers for approximately six days.

7

JOLLS, CLAUDIA L.[1] and CYNTHIA L. HATLEY[2]. East Carolina University[1] and University of Michigan Biological Station[2]--Nectar content differences between the genders of the bladder campion, Silene vulgaris.
Theory suggests that females are at a disadvantage compared to hermaphrodites in a gynodioecious species. Females contribute genes only as maternal parents through seed set, while hermaphrodites set seed and function as pollen parents in self- or cross-fertilization. Females may be maintained in populations by having reproductive output greater than that of bisexuals. This study is part of a larger empirical effort to document the relative reproductive success of hermaphrodites and females of Silene vulgaris. We have reported previously, contrary to prediction, greater reproductive output in hermaphrodites; however, a greater proportion of female flowers set fruit. The present study investigated this differential fruit set by comparing attractiveness of the two genders, measured as nectar content. Although data from a hand refractometer showed no significant difference in sugar content between the genders (15.5% ± .85 vs. 14.4% ± .41), use of a spectrophotometric assay for minute quantities of sugar revealed significantly more total rinsable sugar in the nectaries of hermaphrodites compared to females (.938 mg ± .105 vs. .515 ± .09). Nectar sugar content changed in both genders through time, peaking at stigma receptivity. Neither of the genders appear to be preferentially visited by pollinators, therefore, we hypothesize that the greater fruit set in females is due to genetic factors such as reduced inbreeding depression rather than differential attractiveness and pollinator visitation.

8

McDEARMAN, WILL and ALBERT B. PITTMAN. Mississippi Museum of Natural Science and Vanderbilt University--Staminate and pistillate spectral cues in Zigadenus glaberrimus.
Previous studies of this protandrous hermaphrodite have demonstrated that nectar is produced almost entirely by male-phase flowers. Honey bees preferentially visit male flowers, but not to the exclusion of female-phase flowers. In this study, we examined the correspondence of spectral cues to nectar availability and sexuality. We found that reflectance patterns (ca. 300-650 nm) of the radial perianth were essentially identical for male, virgin female, and post-pollinated female (24-48 hrs.) flowers. However, nec-

tar itself located on and adjacent to the exposed nectaries was flurorescent and highly UV reflective. When the rate of nectar removed by pollinators exceedes accumulation rates, male/female discriminatory cues apparently diminish. Under these conditions, unrewarding females which appear similar to nectarless males are likely to be visited. When the reproductive success of a dichogamous species is enhanced by temporally distinct sexual phases, alternative patterns of male/female nectar secretion, and preferential male/female visitation, we suggest that evolution of the discriminatory spectral cues will be constrained by intersexual conflict.

9

HUDSON, JARVIS E. Fayetteville State University--Ten years of change in an Appalachian oak forest.

In order to observe population dynamics of trees and to predict changes in tree species composition in a young Appalachian oak forest density of tree seedlings and saplings was monitored from 1975 to 1985 and density and basal area of canopy trees (trees 10.2 cm DBH) were measured in 1977, 1981, and 1985. From 1975 to 1977 among the 5 most common species of seedlings recruitment exceeded mortality only in Sassafras albidum and Quercus prinus. During the same time interval recruitment was lower than mortality in each of the 5 most common species of saplings. Density of seedlings fluctuated between 18,890 /ha. in 1977 and 22,820/ha. in 1985. Density of saplings declined from 9413/ha. in 1975 to 4810/ha. in 1985. Density of canopy trees declined from 695/ha. in 1977 to 604/ha. in 1985. Relative density of Nyssa sylvatica saplings varied from 47.8% in 1977 to 39.0% in 1985, and Oxydendrum arboreum from 12.8% in 1976 to 7.8% in 1985. Relative density of Acer rubrum saplings increased consistently from 11.9% in 1975 to 22.9% in 1985. From 1977 to 1985 among the 13 species represented by canopy trees relative density declined from 45.9% to 37.1% in Quercus coccinea and from 3.4% to 1.7% in Pinus rigida. In the same time interval relative density increased from 40.1% to 47.4% in Quercus prinus and from 1.5% to 4.3% in Acer rubrum. From 1975 to 1985 species diversity (H') of seedlings decreased from 1.963 to 1.856 but H' for saplings increased from 1.760 to 1.902. From 1977 to 1985 H' for canopy trees increased from 1.278 to 1.345. Several types of evidence suggest that there will be continued decrease in importance of Quercus coccinea and 3 species of pine and that there will be continued increase in importance of Quercus prinus and Acer rubrum.

10

SHOTOLA, STEVEN J., George T. Weaver and William C. Ashby. Southern Illinois University-- Structural and compositional changes from 1957 to 1985 on two abandoned fields in Southwestern Illinois.

Two areas in the Shawnee Hills of Southern Illinois were abandoned from farming in the mid to late 1920's. The areas were first inventoried in 1967 for all woody vegetation after 40 years of old field succession. A repetitive study in 1985 documents the continuing changes that have occured on these areas. The first area, on an east facing slope adjacent to a virgin Maple-Oak-Hickory forest, was dominated by Liquidamber styraciflua, Sassafrass albidium and Quercus velutina in 1967. The stand basal area increased from 13.1 to 25.5 m^2/ha and stand density increased from 943 to 1199 trees/ha from 1967 to 1983. Liouidamber styraciflua and Sassafrass albidium are being replaced by Quercus velutina, Acer saccharum and Quercus muhlenbergii. The second area, on a north facing slope, is highly dominated by Liriodendron tulipifera. Stand basal area increased from 24.0 to 35.9 m^2/ha and stand density declined from 1040 to 672 trees/ha between 1967 and 1985. Liriodendron tulipifera, Ulmus americana and Fraxinus americana are increasing in the stand, while Morus rubra, Nyssa sylvatica and Acer negundo have declined in the woods. Even though both areas were abandoned at approximately the same time, the stands are at different stages of successional development. The first stand is showing structural development and is increasing in species diversity, while the second stand appears structurally mature.

11

SMALLIDGE, P. J., J. E. PINDER, and F. B. GOLLEY. Savannah River Ecology Laboratory--An anomalous secondary successional pattern in a South Carolina old field.

Although Field 3-412, a 400-acre old field on the Savannah River Plant, has been abandoned for 35 years, it supports a grass and shrub community instead of the pine dominated forest expected from previous studies of succession in the Southeast. Some isolated loblolly pines (Pinus taeda) exist in the field, and it was thought that once these trees became reproductively active that young pines would be established in the gaps among the mature pines. This has not occurred. There has been little reproduction. Although some trees have produced over 100 offspring, many trees have produced less than 15. Some trees have produced no offspring. Approximately 50% of the second generation trees are beneath the canopies of the mature trees, and few offspring are more than 15 m from the parent tree.

12

ANDERSON, LORAN C. Florida State University--Hurricane effects on Apalachicola (Florida) barrier island vegetation.

Hurricane Elena's erratic course in 1985 in the Gulf of Mexico passed by these islands twice, and considerable damage occurred to the flora. The flora of Dog Island has been recently documented. It has the northernmost stations for Avicennia germinans and

Thelypteris interrupta in the Gulf of Mexico. The mangroves survived the storm, but the ferns apparently did not. About 64% of the angiosperm taxa on the island are aquatics or wetlands plants. The freshwater marshes received salt water overwash from the storm, and most marsh vegetation, including shrubs and trees bordering the marshes, was killed back. Recovery rates are being monitored; certainly the species diversity on the island has been reduced. Cape St. George Island projects further into the gulf than the other Apalachicola barrier islands, and it perhaps sustained the greatest damage. The beaches were eroded vertically by nearly a meter, and the scouring removed all beach vegetation, such as Cakile constricta, Ipomoea imperati, and Oenothera humifusa. Nearly all plants on the island sustained wind and salt-spray browning of their leaves, and many were defoliated. Salix caroliniana was the first to sprout new growth (within a few days!), but S. nigra took longer to resprout even though it was in more protected sites. After the storm, several spring-blooming species produced flowers with their new foliage. Elena did not pass directly over the islands, and recovery from defoliation is progressing well for most taxa. However, another record-breaking cold winter would be a serious set-back for the plants with tender foliage.

13

COLLINS, B.S. and S.T.A. PICKETT. Savannah River Ecology Laboratory, and Rutgers University--Influences of experimental canopy gaps on the dynamics of herb layer species in a northern hardwoods forest.

Three single- and three multiple-tree gaps were created in an Allegheny Plateau northern hardwoods forest to investigate responses of herb layer species to canopy opening. Cover, number, and size of herbs and tree seedlings beneath opened, transitional, and closed cnaopy were determined during one season before and three seasons after gap creation. Neither cover, size, nor number of spring and summer herbs was influenced by either single- or multiple-tree openings. Cover of Prunus serotina seedlings was primarily affected by Hydria prunivorata herbivory; however, positive response to multiple-tree gaps was also seen. These results indicate that herb layer dynamics in this secondary forest are not tightly attuned to canopy disturbances of the magnitude created in this research.

14

HUPP, CLIFF R. Woody vegetation and bank processes along modified West Tennessee streams.

Many West Tennessee streams have been straightened and periodically dredged and cleared since the turn of the century. These operations significantly affect bank-form further upstream as well as along recently modified reaches. Typically, dredging and clearing initiates a period of upstream degradation followed by channel widening, resulting from increased gradients downstream. These processes and gradients in turn affect the riparian vegetation; analysis of the vegetation provides otherwise unobtainable information about bank-form changes and their rates. Riparian vegetation, bank-form, and bank processes were investigated in the Obion and Forked Deer basins, and along modified tributaries of the Hatchie River. Plant ecological and dendrochronological analyses have allowed for the determination of channel widening rates, bank accretion rates, relative bank stability, and the role various woody species play in recovery from channel modification disturbance. Channel widening rates as much as 3 meters per year and bank accretion rates as much as 15 centimeters per year have been determined in the Hatchie River basin. The first woody species to revegetate degraded banks include Salix nigra, Betula nigra, Acer negundo, and Fraxinus pennsylvanica. Earliest re-vegetation occurs on mid-bank surfaces where initial bank accretion also occurs. Further vegetation establishment enhances deposition and bank stability.

15

PITTMAN, ALBERT B. Vanderbilt University--Systematic studies of intraspecific variation in Scutellaria saxatilis Riddell.

Scutellaria saxatilis Riddell (Family: Labiatae) is a widely ranging but very localized Appalachian Mountain endemic. Great morphological variation can be correlated with its extremely diverse habitats. In moist to mesic woodland sites, this species is trailing in habit with leaves thin, glabrous and ovate, gradually merging into leaf-like floral bracts which exceed calyxes and even flowers. In seasonably very xeric habitats, such as the shale and sandstone outcrops of southwestern Virginia, this species is erect in habit, the entire plant densely hirsute with thick, lanceolate to reniform leaves. The floral bracts are minutely subulate, thus quite distinct from the median leaves below. Predictably, this variation has led to questions of taxonomic rank and has confounded its identification and nomenclature. Populations of the two forms were analyzed electrophoretically to determine their genetic similarity based upon allozyme patterns. These patterns indicate that both forms are nearly genetically identical and therefore do not merit taxonomic rank beyond the level of forma. Also, photographic spectral analysis of the flower was employed to determine the stability of nectar-guide corolla patterns in a species that is morphologically and ecologically variable but expressing a high index of genetic similarity.

16

BOUNDS, RICHARD R. North Carolina State University--*Numerical taxonomic studies of Rhexia spp.*

Rhexia is a small genus of the Melastomataceae and is distributed in the southeastern United States. Previous taxonomic treatments by C.W. James (1956) and by R. Kral and P.E. Bostick (1969) differ in the recognition of taxa either as species or as varieties. Neither of these treatments is completely satisfactory in delimiting taxa associated with the *R. mariana*-*R. virginica* complex of variation. Qualitative and quantitative data from species descriptions in these treatments were assessed using numeric taxonomic methods. A similarity coefficient comparing each pair of taxa for ten quantitative characters indicated phenetic similarity between *R. mariana* and *R. nashii* and between *R. mariana* and *R. ventricosa* (*R. mariana* var. *ventricosa* sensu Kral and Bostick). Comparisons between taxa of the Mariana-Virginica complex using six qualitative characters suggest phenetic similarities between *R. virginica* and both *R. ventricosa* and *R. interior* (*R. mariana* var. *interior* sensu Kral and Bostick).

17

HOLLOWELL, VICTORIA C. and THOMAS R. SODERSTROM. University of South Carolina, and Smithsonian Institution--*Generic constraints within the subtribe Parianinae (Poaceae: Bambusoideae: Olyreae).*

The Parianinae are herbaceous bambusoid grasses indigenous to wet forests of tropical America. Plants of this subtribe produce spiciform inflorescences with gynecandrous spikelet whorls and leaves with oral setae, and, like other grasses of the tribe Olyreae, are monoecious and bear 1-flowered spikelets. Two genera, *Pariana* and *Eremitis*, are currently recognized in the subtribe. The larger genus, *Pariana*, consists of more than 30 species distributed from Panama to Bolivia and throughout the Amazon Basin. *Eremitis* contains five species endemic to the eastern coastal forests of Brazil. A new genus, composed of two known species from Costa Rica, is recently identified. Inflorescences range from dimorphic and subterranean in *Eremitis* to monomorphic and aerial in *Pariana*. Inflorescences of the new genus differ in spikelet organization and often occur on specialized decumbent culms. Differences in chromosome, lodicule and stamen number, as well as spikelet morphology further delimit these genera of bambusoid grasses within the Parianinae.

18

HARDIN, JAMES W. and LOIS H. GARNER. North Carolina State University--*Autochory in Illicium.*

Illicium floridanum and *I. parviflorum* have an aggregate of laterally flattened follicles radially spreading in a stellate pattern. Each follicle contains a single seed held dorsally and attached near the base of the carpel. Upon drying, the thin dorsal pericarp shrinks and causes the ventral suture to dehisce. Continued shrinkage of the dorsal wall pushes the free, broad, chalazal end of the seed upward. The ventral walls of the endocarp are thick, very hard, and extremely smooth. When the smooth, shiny, slippery seed is against the smooth endocarp, the funiculus breaks and the seed is shot out suddenly to distances of 3-4 meters. This ballistic mechanism depends on: (1) differentiation of the dorsal and ventral portions of the pericarp; (2) differential drying and shrinkage of the two portions of the pericarp; (3) ventral dehiscence; (4) ventral 1/3 of endocarp very hard and smooth; (5) seed laterally flattened, slightly obovoid, and with smooth, very hard testa; (6) seed held by funiculus until oriented ventrally and more vertically in the follicle; (7) tapered seed with smooth, slippery wall held with pressure against smooth endocarp until funiculus breaks; (8) divergent orientation of follicles perpendicular to the peduncle. This autochorous, short-range dispersal may be coupled with endo- or syn-zoochory for longer ranges. A similar mechanism is found in the capsules of *Hamamelis*, but autochory in *Illicium* is apparently unique in the Magnoliidae.

19

SIWUNDLA, NOMPEMBELELO AND JON STUCKY. North Carolina State University--*Systematic anatomy of leaves, cotyledons and pericarps in Sesbania of the southeastern United States.*

The Sesbania (Fabaceae) complex is represented in the southeastern U.S. by *Daubentonia drummondii*, *D. punicea*, *D. virgata*, *Glottidium vesicarium* and *Sesbania exaltata* (nomenclature of Radford et al.). Taxonomic treatments of this complex based primarily on fruit morphology have varied; some grouping all species in *Sesbania*; others allocating species to *Glottidium* and *Daubentonia*. Most recently, only *Glottidium vesicarium* has been segregated. Leaf anatomy of all species was found to be similar for palisade mesophyll thickness, distribution of crystals and distribution of tannin deposits. Cotyledons of all species have clearly differentiated palisade and spongy mesophyll regions and the same number of palisade cell layers. Pericarps of all species are similar for the number and type of cell layers in the mesocarp region, relative position of the major veins in the pericarp and distrihution of tannin deposits. The pericarp wings of *Daubentonia* species are composed of cell types similar to those of the exocarp and mesocarp regions of all species. Despite the differences in fruit morphology that constitute the basis for the various degrees of splitting of previous taxonomic treatments, the comparative anatomy argues for the inclusion of all species in the same genus.

20

HAYNES, ROBERT R. University of Alabama --A Revision of Hydrocleys (Limnocharitaceae).

Hydrocleys is a genus of aquatic vascular plants native to the neotropics and subtropical South America. The plants all have floating leaves, segmented stems, and emergent flowers. The genus consists of five species that can be separated by number of stamens and staminodia, size of flowers, venation of sepals, and seed coat characteristics.

21

JONES, RONALD L. Eastern Kentucky University--The distribution of Aster georgianus Alexander in the Carolinas.

Aster georgianus is a large-headed, late-flowering species restricted to the Piedmont. It is often confused with either A. patens Ait. or A. grandiflorus L., or as a hybrid of the two. Systematic studies have shown that A. georgianus differs from these two species in its colonial habit, white disc, and chromosome number of 2n=50. A remaining question concerns the rarity of the plants. Only 23 counties in the southeastern U.S. were documented, with nine in the Carolinas. A 1985 field study of the species involved about 1000 miles of travel through the Piedmont counties of North and South Carolina. Despite this extensive search, only seven populations were located. These populations tended to be very small, consisting of a few colonies, with 10-100 aerial stems. They were generally located on clayey soils, in thickets near oak-pine woods. New county records were as follows: Rowan Co. NC, Lauren Co. SC, Union Co. SC, and York Co. SC. The results of this field study suggest that populations of this species are small, isolated, and very infrequent in the Carolinas. Additional studies are needed, but present data indicate that A. georgianus is a species in need of protection, and therefore status as a threatened or endangered species of North and South Carolina.

22

STOKES, GLENN D. AND WILLIAM S. BIRKHEAD. COLUMBUS COLLEGE--pH as an isolating mechanism for two Cyprinid fish.

Notropus euryzonus and N. venustus are found in confluent creeks (Pineknot and Upatoi Cr. repectively) but are not observed crossing between creeks. A physiological barrier between the creeks was proposed. There is a significant difference in pH between the creeks. Upatoi pH ranged between 6.0 and 7.1 and Pineknot 3.5 and 5.3. To demonstrate the physiological barrier, 6 fish of each species were translocated monthly and held in traps. 93.7% of the translocated N. venustus died in 96 h (39.6% mortality of controls), whereas 45.8% of the translocated N. euryzonus died (14.6% mortality of controls). 100 fish of each species were placed in individual containers with 2 l of native creek water adjusted to pH 3, 4, 5, 7 or 9 (20 fish per pH). Fish mortality occured at pH 3 and 4. 100% of both species died at pH 3 within 8 h. N. euryzonus had a 4 h mean survival time compared to 1 h for N. venustus at this pH. At pH 4, 83.3% of the N. venustus died within 96 h compared to 22.2% of the N. euryzonus. Intolerance of low pH is sufficient to explain the absence of N. venustus from Pineknot Cr. Stimulation of gill mucous cells may be inhibiting oxygen transport.

23

BIRKHEAD, WILLIAM S., GEORGE E. STANTON, and GLENN D. STOKES. Columbus College--Fishes of the Upatoi Creek Drainage, Westcentral Georgia.

Three tributary assemblages in Westcentral Georgia form Upatoi Creek, a fifth order tributary of the Chattahoochee River draining a substantial portion of Fort Benning Military Reservation. The three assemblages are defined on the basis of physical and chemical characteristics. Flowing southward, fall line tributaries exhibit the most variable discharge rates and thermal regimes, contain the most conductive water and have essentially neutral pH's. Tributaries draining sandhills from the east have comparatively stable discharge rates, less variable thermal regimes, low conductivity and low (3.5-5) pH's. Tributaries entering from the southeast display physical-chemical characteristics intermediate to the other two. Stream fishes were collected by seining and electrofishing; beaver-impounded tributaries and oxbows were sampled by means of rotenone. Fifty species taken included 14 centrarchids, 11 cyprinids, 5 catastomids and ictalurids and 4 percids. Fall line streams supported richest fish assemblages. Ericymba buccata, Hybopsis, sp. cf. winchelli, Notropis longirostris, N. venustus, Semotilus atromaculatus and Lepomis auritus (10-100 individuals per $100m^2$) were dominant. Ichthyomyzon gagei and Notropis euryzonus were dominant in sandhill drainages, the most depauparate streams. Beaver pond assemblages differed markedly from those in streams; Notemigonus crysoleucas, Erimyzon sucetta, Lepomis gulosus and Lepomis macrochirus were dominant within an impounded fall line stream, but only E. sucetta was dominant in an impounded sandhill stream. An analysis of ecological factors that might explain these distribution patterns is discussed.

24

LAYZER, JAMES B. and MICHAEL D. CLADY. Tennessee Cooperative Fishery Research Unit and Oklahoma Cooperative Fish and Wildlife Research Unit--Phenotypic variation of young-of-year bluegills (Lepomis macrochirus) among microhabitats.

Young-of-year bluegills were collected with minnow traps set in different microhabits defined by depth and the presence or absence of vegetation within the littoral zone of a 20.9 hectare lake. Analysis of covariance indicated that regressions of log transformed measurements of body depth, caudal peduncle depth, and head length on standard length were significantly different among fish from different microhabits. Bluegills collected at depth ≤50 cm were more robust and grew faster in both length and weight than fish collected at greater depths. Bluegills collected at depth >150 cm were more fusiform in body shape but increased in length and weight at a rate similar to fish collected from intermediate depths. The consistency in these relationships between years (for two cohorts) suggests that the differences were not due to chance. Unlike body measurements, counts of soft dorsal rays, anal fin rays, and dorsal spines differed little among habitats. The number of lateral line scales were significantly different between fish collected at depths 150 cm and those collected from shallower areas.

25

SIMONSON, TIMOTHY D. and RICHARD J. NEVES. VA Coop. Fish and Wildl. Res. Unit, Dept. of Fisheries and Wildlife Sciences, VA Polytechnic Institute & State University, Blacksburg, Virginia--*Distribution, Abundance and Habitat of the Orangefin Madtom in Virginia and North Carolina*.

The orangefin madtom (*Noturus gilberti*), an endemic species to the upper Roanoke and James River drainages, is currently under review for federal listing as threatened. In order to determine it's present distribution, abundance and habitat requirements, extensive surveys were conducted in Virginia and North Carolina. We found the orangefin madtom to be substantially more widespread than previously reported. Abundance and range varied considerably among river systems sampled. Habitat selection by the madtom was generally narrow and most often included riffles devoid of silt. The variation in abundance, range and habitat utilization among systems was due primarily to the availability of suitable habitat, which is described.

26

MOORE, CHRISTOPHER M. and RICHARD J. NEVES Virginia Cooperative Fish and Wildlife Research Unit[1], Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University--*Food Resource Partitioning Among Coexisting predators in Smith Mountain Lake, Virginia*

Partitioning of food resources among coexisting predatory fish species was examined in Smith Mountain Lake, a large hydroelectric reservoir located in southeastern Virginia. Food habits of each predatory species were assessed and compared by season using Schoener's (1970) diet overlap index. Alewives and gizzard shad, and to lesser extent crayfishes and sunfishes were the predominant food items consumed by predators in this lake. Significant diet overlap (greater than 0.6) occurred between the pelagic predators (striped bass and walleye) and the littoral black basses (largemouth bass and smallmouth bass) in all seasons and locations where adequate stomach samples were available for comparison. Habitat partitioning and abundance of forage items minimized potential competitive interactions between predators.

[1] The Virginia Unit is jointly supported by the United States Fish and Wildlife Service, the Virginia Commission of Game and Inland Fisheries, the Wildlife Management Institute, and Virginia Polytechnic Institute and State University.

27

MAY, RODERICK L. and R. DON ESTES. Tennessee Cooperative Fishery Research Unit--*An Age and Growth Study of Paddlefish (Polydon spathula) in three Subimpoundments in North Western Tennessee*.

Age and growth data was estimated from annual rings in sections of dentary bones from 150 paddlefish (*Polydon spathula*) collected from three subimpoundments of the Cumberland River and Lake Barkley, Tennessee. Body length (eye to fork length) was better than total length for estimating fish size because of the highly variable relationship of rostrum length to total length. Mean length at capture was positively correlated with the surface area of the subimpoundment. Large mature females were more abundant than large mature males in all subimpoundments.

28

FEEMAN, JOE C. Tennessee Valley Authority --*The effect of physical alterations on the fish fauna of Coal Creek, Anderson County, Tennessee*.

Coal Creek, a small tributary to the Clinch River (Tennessee River drainage) in Anderson County, Tennessee, has undergone several physical alterations beginning with channelization in 1972. The physical character was changed from boulder-rubble substrate, moderate canopy cover, and high pool-riffle ratio to a shifting sand-gravel-silt substrate, very low canopy cover, and a low pool-riffle ratio. Five years after channelization, in-stream gabions were constructed to improve the pool-riffle ratio and provide more suitable habitat for desired species of game fish. The relative abundance of fish species has changed with each physical alteration. After channelization, there was an increase in numbers of *Campostoma anomalum*, *Notropis chrysocephalus*, *Pimephales notatus*, *Fundulus catenatus*, and *Etheostoma jessiae* and a decrease in numbers of *Ambloplites rupestris* and *Micropterus dolomieui*. In-stream gabions caused pools to be formed in the previously pooless areas and increased the Centrachidae species numbers. Although Coal Creek has been under adverse conditions it has remained resilient and maintained a good diversity. There have been shifts in species relative abundance and numbers of certain species have increased. Two species, Notropis ardens and N. stramineus, which had not been previously collected from Coal Creek, were taken and have increased in numbers from subsequent collections.

29

MEFFE, GARY K. Savannah River Ecology Laboratory--Variation in mosquitofish embryo size: population and individual effects.

Some students of life history theory predict an optimal offspring size accompanied by minimal variance, while others suggest that high variance in offspring size may be selectively beneficial, especially in a changing or unpredictable environment. I individually weighed hundreds of embryos from wild and laboratory populations of mosquitofish (Gambusia affinis) in Florida to document the magnitude of variation in propagule size and test the "optimal" vs. "plastic" predictions of theory. A large amount of variance was documented in wild fish from five localities and a laboratory population held under constant conditions. Less than one-half of the variance was attributable to developmental stage, clutch size, or maternal size. Thus, an "optimal" propagule size appears to be lacking in mosquitofish, and much of the variance remains unexplained.

30

REYNOLDS, JOHN D., WILLIAM V. DASHEK, and GERALD C. LLEWELLYN. Virginia Commonwealth University, Atlanta University, and Virginia Department of Health--A Bioassay for Mycotoxins Using the Water Fern, Marsilea quadrifolia.

Aflatoxin B_1 is a secretion of Aspergillus spp. and trichothecene toxin, known as T-2, is a byproduct of Fusarium spp. These are examples of compounds that are currently under intense investigation due to their carcinogenic, mutagenic, and teratogenic properties. T-2 toxin has hemorrhagic characteristics but has not been proven to be a carcinogen. T-2 toxin has allegedly been used as a chemical warfare agent and thus simple and rapid bioassay systems would be of value. In this study megaspores from the water fern (Marsilea) were placed in tissue culture multi-well plates and treated with various concentrations of both toxins. Each well contained 3 to 5 megaspores. Control wells received distilled, sterile water and the solvent used to carry the toxin. Archegonial formation, fertilization, and resultant sporophyte development were observed at least daily for 3 to 5 days for each of the studies undertaken. Toxin treatment of the fertilized system consisted of a 1-hour exposure to the toxins followed by 3 washes using sterile, distilled water. Fertilized megaspores were then allowed to develop and were examined. Aflatoxin B_1 reduced megaspore release at 1 ppm and 2 ppm. Sporocarps at 20 ppm showed a 71% rate of germination. Percent of megaspores developing normal sporophytes was lineral between 0.314 and 0.039 ug/ml of T-2 treatment. The water fern appears to be quite sensitive to mycotoxins and warrants further investigation as a possible bioassay tool.

31

ORVOS, DAVID R.[1], CLETUS M. SELLERS, JR., and NORMAN E. CARRISON. James Madison University--Optimization of an isolation buffer system for rainbow trout (Salmo gairdneri) liver.

To determine the effect of various environmental toxicants upon the in vitro ribosomal translational efficiency of rainbow trout liver, an optimal isolating buffer system was designed. The system produced ribosomes with maximal functional integrity at the following concentration: Buffer I- sucrose 250mM, Tris (pH 7.6) 50mM, KCl 75 mM, $MgSO_4 \cdot 7H_2O$ 5mM, EDTA 0.1 mM, and 2-mercaptoethanol 3mM; Buffer III- Tris (pH 7.6), KCl 75mM, and $MgSO_4 \cdot 7H_2O$ 8 mM. Buffer II was identical to Buffer I but contained no sucrose and Buffer III-D was identical to Buffer III but with 1.0% Triton X-100 added. Comparison of results from different studies mandates use of an accepted optimal isolation system.

[1] Present address: Center for Environmental Studies and Dept. of Bio., Virginia Tech, Blacksburg, VA 24061

32

ASHLEY, TERRY University of Tennessee--G-band position effects on meiotic synapsis and crossingover.

Synapsis in the quadrivalents of certain X-7 translocations in male mice is confined to homology, while in others there is nonhomologous synapsis near the break point. Evidence is presented suggesting that whether a translocation will synapse homologously or nonhomologously is determined by the position of the break points. If both breaks lie in G-light bands, synapsis in the quadrivalents will be confined to homology. However, if one of the breaks lies in a G-dark band, nonhomologous synapsis will occur. The break points in a series of autosome-autosome translocations in mice have been reexamined and this information correlated with the genetic information on crossingover. In each autosome-autosome translocation with a break in a G-dark band, a rearrangement that places a G-dark band adjacent to a G-light band not previously juxtaposed to a G-dark band results in suppression of crossover in the second chromosome. When both breaks are in

G-light bands not immediately adjacent to G-dark bands, there is no suppression of crossover. It is suggested that the suppression of crossover is related to the nonhomologous synapsis associated with breaks in the G-dark bands. The available genetic data on crossover in the X-autosome translocations supports this hypothesis.

33

FINLAY, MARY FLEMING, DAWN ANDERSON and ANGELA REID. Benedict College--Genetic variation and interaction of intestinal enzymes in the mouse.

Leucine aminopeptidase (LAP) and alkaline phosphatase (AKP) are highly concentrated on membranes of the intestinal villi. The development, regulation and chromosomal location of these enzymes has been investigated among five strains of inbred mice.

By starch gel electrophoresis two variations of intestinal AKP were noted: discrete subbanding/diffuse zone and fast/intermediate mobility. In F_1-hybrid and backcross animals subbanding was dominant to diffuse; fast dominant to intermediate; and the variants were independent. Intestinal LAP was either a single, discrete band with fast mobility or a diffuse, slower zone. The diffuse LAP electromorph was uniformly associated with diffuse intestinal AKP. Epistasis or common processing are possible causes of this association.

The intestinal AKP variant affecting rate of migration was independent of Idh-1, on chromosome 1 near Akp-1 and Akp-3, and also of black (b) on chromosome 4, where Akp-2 is placed. It is termed tentatively Akp-4. A close association between this variant and both serum LAP and AKP was demonstrated as well.

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34

MURDY, WILLIAM H. and M. ELOISE BROWN CARTER. Emory University--Variable expression of duplicate genes in Talinum calcaricum Ware.

An electrophoretic survey of four Talinum calcaricum populations revealed that duplicate genes, which specify ADH, LAP, MDH, PGI and TPI enzymes, varied in expression. In some populations, duplicate genes were expressed in the form of a fixed heterozygote. In others, one gene of a duplicate pair was either polymorphic for the presence and absence of an isozyme or not expressed at all. These results are discussed with respect to both the importance of gene silencing in the genetic diploidization of polyploids and the evolutionary origin of T. calcaricum.

35

BOGITSH, BURTON J. and K. F. KIRSCHNER. Vanderbilt University--Further ultrastructural studies on hemoglobinase activity in Schistosoma japonicum.

Mercury-labeled pepstatin was used to demonstrate the site of a pepstatin-sensitive hemoglobinase in paraformaldehyde-fixed adult Schistosoma japonicum. Pepstatin was covalently attached to glutathione using dicyclohexylcarbodiimide followed by the addition of methyl mercury. Reaction product was observed in lipid-like globules and in autophagic vacuoles in the gastrodermis. Immunocytochemical studies at the electron microscope level were used to complement inhibitor studies. A primary antibody was raised against bovine cathepsin D and partially purified with ammonium sulfate. Sections of adult worms were incubated in the antibody, incubated in protein A-peroxidase, and visualized with DAB and peroxide. Reaction product was observed in the same sites as in previous inhibitor experiment. The function of lipid-like globules in the digestive activities of the organism will be discussed.

36

JOHNSON, SANDRA STRAWBRIDGE, SHARON PATTON, JIM JENSEN, and ROBERT M. FINCH. University of Tennessee, College of Veterinary Medicine--Survey of animals at the Knoxville Zoological Park for antibodies to Toxoplasma gondii

After an outbreak of toxoplasmosis killed 14 marsupials at the Knoxville Zoological Park in 1984, a survey was conducted to ascertain the exposure of animals at the zoo to Toxoplasma gondii. Blood was collected from animals in the zoo population whenever they were restrained for any reason. Serum was collected and tested for Toxoplasma antibodies by the indirect hemagglutination test (IHA). The following animals were checked: African elephant (1), bobcat (1), bushdog (1), black leopard (1), binturongs (2), camels (2), crane (1), Sicilian donkey (1), hyena (1), marsupials (14), Asian and African lions (11), nyala (1), Patagonian cavy (1), lesser and red pandas (5), polar bear (1), primates (26), sunbear (1), and Bengal, Siberian and white tigers (6). Of the 77 different animals titered, 22 (28.57%) were positive for Toxoplasma antibodies with a titer of 64 or higher. This included the binturongs, a hyena, 13 marsupials, an Asian lion, a lesser panda and 4 primates.

37

EVANS, THOMAS E., JR. and GROVER C. MILLER. North Carolina State University--Scanning electron microscopy of Schistosoma mansoni adults from unisexual and bisexual infections.

The teguments of Schistosoma mansoni adults from both unisexual and bisexual infections were studied. SEM studies revealed no discernable differences in the teguments of males from unisexual and bisexual infections and prominent tuberculations on the dorsal surface probably aid in support of the worm in the vertebrate circulatory system. There are considerable differences in the teguments of females from unisexual and bisexual infections. Females from a unisexual infection have a tegument which displays a more irregular and porous dorsal surface. It also has larger and more numerous sensory papillae. The tegument of the female in unisexual infections mimics that of the male tegument which provides additional evidence of the transabsorption of nutrients by the male to the female in bisexual infections and directly by the female tegument in unisexual infections.

38

PATTON, SHARON[1], ALAN R. RABINOWITZ[2], SANDRA STRAWBRIDGE JOHNSON[1]. University of Tennessee, College of Veterinary Medicine[1] and Bronx Zoo[2]--A coprological survey of parasites of wild neotropical felidae.

In conjunction with an ecological study of jaguars in the Cockscomb Basin of Belize, Central America, fecal samples from jaguars, (Panthera onca), jaguarundis (Felis vagouaroundi), ocelots (F. pardalis), and pumas (F. concolor) were examined for parasite products (eggs, larvae and oocysts). Of the 45 samples examined, 39 (86.7%) were positive for parasite products; 23 of 25 (92%) jaguar samples were positive as were all of the puma (4/4) and ocelot (8/8) samples. Four of 6 samples from unknown species were positive (66.7%). Two jaguarundis samples were negative. The following were identified in the samples: Paragonimu sp eggs, Taeniidae eggs, Strongylate eggs, Toxocara cati eggs, Toxascaris sp eggs, Capillaria sp eggs, Spiruridae eggs, Aelurostrongylus sp larvae, Oncicola sp eggs, Hammondia pardalis oocysts, Isospora sp oocysts, Toxoplasma gondii-like oocysts and Sarcocystis sp sporocyst.

39

SCOTT, EDGAR L., III, ROBERT B. JEPPSEN and M. GUNASEKARAN. Fisk University--Lipid Analysis of Tilletia controversa.

Tellita contraversa is a soil borne phytopathogenic fungus which causes dwarf bunt disease in wheat. It creates a major problem in wheat growing regions throughout the world. Dormant spores are known to have a high level of lipid reserve, which provides energy for their germination. The objective of this study was to determine the lipid content in dormant and germinated spores. Spores were broken by a french press and the lipids from cell free homogenates were extracted with a chloroform:methanol (2:1) mixture. Extracted lipids were separated into various fractions, such as neutral and polar lipids, monoglycerides, diglycerides, triglycerides and sterols, by Thin Layer Chromotography using a solvent system consisting of petroleum ether, diethyl ether, and acetic acid, 65:35:1.5 (v/v/v) respectively. Each fraction was eluted from the TLC plate, transesterified and analyzed by Gas Chromotography (Perkin Elmer 2000). A 10 meter fused-silica capillary column (Alltech, SE-30) was used to separate the fatty acid esters. These esters were identified and confirmed by GC-MS (Hewlett Packard). Large numbers of short chain acids were apparent in the polar lipids. The shift in the degree of fatty acid unsaturation between dormant and germinated spores and their role in spore germination and development will be elucidated.

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40

HOBDEN, JEFFERY A. AND J. M. UPADHYAY. Loyola University--Isolation of thermophilic and thermotolerant geofungi from the Yucatan Peninsula, Mexico.

To isolate thermophilic (maximum temperature for growth at or above 50 C, minimum temperature for growth at or above 20 C) and thermotolerant (maximum temperature for growth at or above 50 C, minima well below 20 C) molds, Potato Dextrose Agar (PDA), Malt Yeast Agar (MYA), and Malt Extract Agar (MEA) plates were directly inoculated with soil particles from previously unsampled sites in Yucatan, Mexico. Bacterial growth was inhibited by adjusting the pH of the medium to 3.5 with 10% lactic or tartaric acid or by adding 50 mg/l streptomycin sulfate and 100 U/l penicillin G to the medium. The plates were incubated at 50 C to exclude the growth of mesophilic fungi. Pure cultures were obtained by streaking and restreaking spores from isolated colonies. Isolates were grown on PDA (pH 5.6), MYA (pH 6.8), and MEA (pH 6.8) at 45 C and evaluated for growth, zonation, color, and exudate formation. Based on anamorph and teleomorph morphology, 3 thermophilic molds, Chrysosporium pulverulentum, Talaromyces emersonii, and Thermoascus aurantiacus var. levisporus and 4 thermotolerant molds Aspergillus fischeri, A. fumigatus, A. nidulans, and Paecilomyces variotii were isolated.

41

SAMBANDAM T. and M. GUNASEKARAN. Fisk University-- Partial Purification and Properties of Phosphorylase from Phymatotrichum omnivorum.

Phymatotrichum omnivorum, a fungal pathogen, which causes cotton root rot disease, accumulates glycogen 36% by dry weight of the organism. Our primary interest was to isolate the enzyme, phosphorylase from the mycelium and study its properties. Fungus was grown in potato dextrose broth for 15 days as stationary culture at 28°C. Enzyme was extracted from the fresh tissue with Tris- HCl buffer (pH 8.0, 0.1M) using acid washed sand; the resulting slurry was centrifuged at 20,000 x g for 20 min at 4°C and the supernatant was used as enzyme source. Enzyme assay was done in the direction of glycogen catabolism following the appearance of NADPH at 340 nm. Enzyme preparation was stable at pH 7.0. It retained 75% of the original activity after 24h. Partial purification was done by ammonium sulphate fractionation. Maximum activity was found at 20-60% saturation level. Substrate specificity, effect of inhibitors, pH and Km value were determined using partially purified enzyme. The results of these studies along with the importance of the enzyme on the physiology and survival of the organism will be presented.

Supported partially by the grants, RII 8405848 (NSF), RR-08062, 5T34GM07675 (NIH) 120AH4005H (Department of Education) and 80501-048 (Department of Energy).

42

PERRY, JAMES W. Frostburg State College-- Ultrastructural aspects of Monotropa uniflora: ectomycorrhiza and phloem.

Two aspects-the ectomycorrhiza and the phloem-of the roots of the achlorophyllous flowering epiparasite Monotropa uniflora have been examined by transmission electron microscopy. A previous ultrastructural report of plants collected from the midwestern U.S. indicated that the fungal component of the ectomycorrhizal association was a member of the Basidiomycotina, based upon the dolipore septum separating hyphal cells. Indeed, Boletus, and Armellariella spp. are commonly found on sites with Monotropa. In West Virginia and Maryland, minute apothecia, fruiting bodies of members of the Ascomycotina, are commonly found from October through December, leading to a published report concerning an ascomycetous mycorrhiza. Preliminary observations at the ultrastructural level on Maryland-collected plants reveal the presence of dolipore septa; thus it appears highly unlikely that the fungal component of the mycorrhiza from plants collected for this study is an ascomycete. As an achlorophyllous parasite, the phloem tissue of the roots might be expected to be dissimilar from that of photosynthetic angiosperms. Earlier light microscope studies on the stem indicated the lack of P-protein in the sieve elements and the absence of companion cells, both features that are characteristic of most dicotyledonous plants. During the current TEM study of the roots, P-protein has been identified as both discrete bodies and strands traversing sieve area pores. Moreover, cells that are cytoplasmically dense and which occupy a spatial position typical of companion cells are present. Typical sieve element- companion cell connections are yet to be observed, however.

43

SMOCK, LEONARD A. Virginia Commonwealth University--Southeastern U.S.A. blackwater river systems - an overview.

Blackwater streams and rivers dominate the river systems of the coastal plain of the southeastern U.S.A. These streams have many physical, chemical and biological characteristics that together make them unique when compared with streams in other geographic areas of the United States. Two factors, controlled by watershed gemorphology, are of overriding importance to the water chemistry and ecology of these streams:
1) the close coupling of stream channels with their often extensive floodplains;
2) the predominance of relatively homogenous, sandy, unstable substrates in the stream channels. These two factors have a major impact on population, community and ecosystem level structure and function. Such factors as the storage, processing and transport of detritus and macroinvertebrate community composition, habitat utilization patterns and production dynamics are very different from those found in higher-gradient streams. The floodplains are the functional headwaters of these river systems, being the location of the majority of leaf litter processing and storage. Thus, exchanges of organic matter between the stream channels and their floodplains are particularly important in determining higher level biological interactions. Because of these factors, macroinvertebrate community composition does not strictly follow the River Continuum Concept, with a paucity of shredders and scrapers in the headwaters and middle-order streams, respectively. Filterfeeders and collector-gatherers are the predominant feeding groups present throughout the river systems.

44

NOLTEMEIER, DEBORAH D., MARK M. BRINSON, DON HOLBERT, and MARTHA N. JONES. East Carolina University--Variation in Water Chemistry in Blackwater Streams in the Coastal Plain of North Carolina.

Ten streams in the central Coastal Plain of North Carolina were monitored to assess how water chemistry varied between streams that drained peatlands and those that drained watersheds with predominately mineral soils. Peat-draining streams had higher concentrations of organic carbon and lower levels of dissolved oxygen, pH, total alkalinity, cations, and inorganic N and P than did mineral soil-draining streams. Several statistical approaches were helpful in identifying parameters that best distinguished the two categories of streams. Although these low-gradient streams are collectively referred to as "blackwater", their water chemistry differs in response to variations in lithology and watershed cover.

45

BLOOD, ELIZABETH R. University of South Carolina--Biogeochemistry of blackwater Coastal Plain streams.

In the southeast Coastal Plain many of the first and second order streams are blackwater low pH, low nutrient and have different hydrologic response to precipitation than similar order mountain streams. Much of our understanding of nutrient cycling, litter dynamics and production has been developed from analyses of "white water" streams. Organic carbon concentrations range from 10-30 mgl^{-1} and is a dominant factor regulating pH, nutrient dynamics and ionic balance. There is a predominance of organic and reduced forms of nutrients in relatively well oxygenated water. Dissolved ionic strength is low with a shift from a calcium-carbonate system to a sodium-sulfate regulation. Data will be summerized from several blackwater streams in the southeast to provide generalities about the dynamics of nitrogen, phosphorus, and carbon as well as important hydrologic, physical and chemical regulatory mechanisms.

46

SMITH, G.W. and D.A. MCCLARY. University of South Carolina, Aiken, SC--The importance of ammonification in nitrogen cycling at Blackwater sites.

In the environment nitrogenous compounds are subject to microbial transformations. Specific transformations and reaction rates are dependent on the physical and chemical environment as well as the endogenous microbial population. The potential of the microflora to carry out these processes indicate the possible fate of nitrogen in the environment. The purpose of this study was to determine the potential transformation rate associated with various components of a fresh water ego system. Microbial processes measured included assimilation nitrification, de-nitrification, nitrogen fixation, and ammonification rates. Samples were taken over a six month period from seven sites and separated into water column, sediments, and rhizosphere components. Results indicated that more nitrogen was transformed through microbial assimilation and ammonification than through any other process. In addition ammonification appeared to play a regulatory role with respect to other microbial transformations, especially nitrogen fixation. These results indicate that ammonification may play a more significant role in nitrogen cycling than previously thought.

47

ENGLISH, WILLIAM R. Clemson University--Relationships between habitat type and aquatic invertebrate community structure.

Upper Three Runs Creek, South Carolina, an unperturbed 4th order Sand Hills stream, is one of the most species rich aquatic habitats in North America, harboring 600+ species of aquatic insects. Habitat heterogeneity and/or partitioning of food resources are hypothesized to account for observed species richness. As a test, five habitats and the food resources available within each habitat were quantified and compared to the community structure, feeding strategy, and production of aquatic macroinvertebrates associated with each habitat. The five habitats studied were: (1) Aquatic macrophytes which provided the greatest surface area per unit of stream bottom and a stable substrate for attachment of filter-feeding organisms. Macrophytes also functioned as a food resource for aquatic invertebrates and reduced current velocity by ca. 70% facilitating the dropping out of drifting organic matter into detrital sorting areas located within the macrophyte beds. (2) The detrital sorting areas, inhabited primarily by collector gatherers, showed the greatest invertebrate diversity. (3) Snags, the only stable habitat other than macrophyte beds, had invertebrate assemblages dominated by filter-feeders. (4) The unstable midchannel comprised most of the stream bottom, but was lowest in species richness. (5) Pools had the least surface area in this stream and lowest density of invertebrates.

48

STITES, DAVID L. and A. C. BENKE. Department of Biology University of Alabama--Estimates of chironomid growth and productivity in a blackwater river.

In a study of the benthic productivity of the Ogeechee River, a 6th order Georgia coastal plain blackwater river, we have measured growth rates of snag and sand dwelling chironomids in a field laboratory setting. River ambient conditions of habitat, temperature and food were closely simulated in a series of growth studies conducted in July and August 1983. Growth rates were similar in all habitats and found to be dependent mainly on the final mass a taxon achieved. Estimates of development times based on these results ranged from 2-4 weeks at a mean temperature of 29°C for the largest and smallest taxa, Corynoneura and Polypedilum, respectively. In the Ogeechee R., with close to 7000° days yearly, this means that annual production to mean biomass (P/B) ratios will be in the range of 40-80. Such high productivities have been postulated but growth rates necessary for this to occur have not been demonstrated previously under natural conditions. These rates will be used in conjunction with monthly field sampling results to estimate production for the river chironomid benthos.

49

CUFFNEY, THOMAS F. University of Georgia--Riparian flooding and the processing and exchange of organic matter in coastal plain streams.

The influence of floods on physical and biological characteristics of two southeastern Georgia streams, the Ogeechee River and Black Creek, were studied over a two year period. Organic matter processing rates, macroinvertebrate community structure and development, and organic matter exchange between rivers and floodplains were quantified and examined with respect to flood duration, intensity, and flood history.

Extent and duration of flooding differed between the two study years (WY 1982 > WY 1982). Floodplains were inundated more frequently and at lower river stages than indicated by USGS flood stage criteria. Depth and % inundation were linearly related to river stage height.

Annual litter fall was significantly greater on the high elevation floodplain (902 g/m^2) than on lower elevation floodplains (ca. 750 g/m^2). Leaf litter processing rates were very slow in floodplain and riverine habitats (range: .0011-.0596 %/d). Processing rates were fastest in rapidly flowing river sites and slowest in floodplain ponds with low oxygen contents. Macroinvertebrate communities associated with leaf litter bags were dominated by collector-gatherers and contained very few insect shredders (<1 per leaf bag).

Low-lying floodplains lost more of their annual litter inputs (ca. 400-600 g/m^2) via flood transport into the river than did higher elevation floodplains (ca. 100-200 g/m^2). Floodplain organic matter represents a substantial organic matter subsidy to Coastal Plain streams.

50

CARLOUGH, LESLIE A. University of Georgia--Protozoa in two southeastern blackwater rivers: possible trophic significance.

The role of protozoa in the structure and functioning of aquatic ecosystems has been relatively uninvestigated until recently. Few descriptions exist about the abundance or production of these organisms, especially in freshwater environments.

This study reports the seasonal population dynamics of protozoan groups in two southeastern blackwater rivers. Their densities range from 0.05-11 x 10^6 flagellates/liter and X.06-15 x 10^4 ciliates/liter. These numbers approximate those reported for various marine habitats. In addition, a backwater site was found to have 3.0 x 10^5 ciliates/liter, the highest density reported for any natural aquatic environment.

A mesocosm study on natural Ogeechee River water showed a density increase from 2.6 x 10^5 to 4.7 x 10^6 flagellates/liter in two days and from 6.6 x 10^3 to 3.8 x 10^5 ciliates per liter in three days. This represents an estimated net protozoan production of 0.4 grams carbon/liter during this three day period. Although problems always accompany container studies, this at least indicates an immense potential for protozoan carbon production in the river.

Further, since the densities of filter-feeding macroinvertebrates are very high in these rivers, protozoa may represent an important trophic link between the metazoans and otherwise unavailable carbon sources.

51

EDWARDS, RICHARD T. and J. L. MEYER. University of Georgia--Metabolism of a sixth order blackwater river in southeastern Georgia.

Diel oxygen curves were used to study the metabolism of the Ogeechee River, a sixth order blackwater river in southeastern Georgia. Ecosystem gross primary production (GPP) and respiration (R) were estimated, and P/R ratios calculated to determine the extent of autotrophy. Rates of GPP were moderate for a river of this size, with seasonal means ranging from 0.90 to 4.23 g O_2 m^{-2} day^{-1}. Primary production was highly variable on a seasonal and yearly basis. Highest rates were observed during summer. Respiration rates were high, with seasonal means varying between 5.48 and 8.3 g O_2 m^{-2} day^{-1}. System respiration was more consistent throughout the year although summer rates were slightly higher. GPP rates were not correlated with incident light levels. Water depth and DOC concentration were significant predictors of GPP, suggesting that attenuation of light by humic materials limits GPP in these waters. P/R ratios ranged from .09 to 1.3 with a mean of .25, indicating that the Ogeechee River was very heterotrophic throughout the year. Evidence suggests that the river floodplain exerts a major influence over both primary production and respiration.

52

IRELAND, PATRICK H. Radford University--Egg deposition, larval growth, and survivorship in spotted salamander (Ambystoma maculatum) populations.

Egg deposition, larval growth, and larval survivorship were monitored for five years in two populations of Ambystoma maculatum using different breeding ponds. The ponds were physically similar; however, the T-pond lacked predatory fish and the Q-pond contained a large population of predatory fish. The number of eggs deposited in the ponds was calculated by two independent methods that produced significantly different results. Larval population size-estimates were made throughout the larval period by mark-recapture techniques. The number of hatchlings/1000 eggs ranged from 350-638. Within each pond, there was significant annual variation in the number of hatchlings/1000 eggs, but significant interpopulation differences were absent four of the five years of this study. Larval growth rates, compared by the Grompertz intrinsic growth constant, were not different. Larval survirorship was remarkably consistent in the T-pond and highly variable in the Q-pond. The number of transformed individuals leaving the T-pond each year ranged from 5-27. Only seven larvae in the Q-pond survived to 120 days and no transformed individuals left the Q-pond. The different survival rates between the ponds was apparently due to differential predation.

53

ASQUITH, ADAM. Mississippi State University--Variation in the mating call of the green treefrog, Hyla cinerea.

Seven variables of calls of thirty frogs from each of six sites ranging from southern Illinois to Louisiana and southern Florida were analyzed. Mean snout-vent lengths of frogs ranged from 28.0 - 61.0 mm among populations. The call is a short honk with several harmonics and frequency peaks at about 1000 and 300 Hz. Strong correlations exist between the low frequency peak and frog size in all populations. These data will be discussed relative to distribution of H. cinerea and its sympatric relative H. gratiosa and factors involving sexual selection and female choice.

54

THIBAUDEAU, D. GISELLE and RONALD ALTIG. Mississippi State University--Developmental sequences of development and atrophy of oral structures in anuran tadpoles.

Comparative studies on equivalental stages of different species provide a basis for systematic and evolutionary interpretations. The ontogenetic development (Gosner stages 17 - 25) of the oral apparatus of 6 species of tadpoles with 4 kinds of oral structures was studied by light and SEM microscopy. Developmental commonality of diverse oral features suggests homologies and relative functional importance of selected structures. Metamorphic atrophy was essentially a reversal of development.

55

BLACKWELL, JEANNE L. and ADAM ASQUITH. Mississippi State University--Feeding and assimilation efficiencies involving sixteen species of amphibians.

Feeding and growth rates and/or assimilation efficiencies (AE) were studied in 9 species of anurans and 7 species of larviform salamanders. Newly-metamorphosed frogs ate increasingly larger numbers of fruit flies weekly, which caused an increase in weekly percentage-weight gain. The average frog almost doubled in weight in its first post-metamorphic month. Average weekly conversion ratios ranged from 3.8 - 15.1 with extremes of 1.0 - 20.4 per week. AE of larviform salamanders feeding on Tubifex ranged from 59.8 - 76.4%. For two species tested at multiple temperatures, AE were higher for animals tested at temperatures that reflected their natural habitats. Adult male hylid frogs had higher AE on prey with low chitin content, and two out of three species fed intermittently had higher AE than frogs fed daily.

56

BONNER, LISA A. and RONALD ALTIG. Mississippi State University--Environmental predictability and amphibian breeding ecology.

A general concept of habitat instability has been suggested as the driving force in the production of amphibian life cycles, but detailed correlations between environmental fluctuations and breeding ecology have not been made. Phenological data collected over a long term are not available. In an effort to gain a large scale evaluation of the degree and kind of environmental fluctuations that breeding amphibians face, we analyzed 87 years of monthly and yearly rainfall data from a mesic site in Mississippi without a definite yearly rainfall cycle and a xeric site in Texas with a definite period of high rainfall from July through September by calculating values of predictability(P), constancy(C) and contingency(M). Values for P, C and M are 0.33, 0.27, 0.06 and 0.40, 0.32, 0.08 for Mississippi and Texas respectively.

57

SCHORR, MARK S. and RONALD ALTIG. Mississippi State University--Ontogenetic acquisition of enteric protozoans by amphibian larvae.

Of 586 citations concerning enteric protozoans of amphibians, few papers concern tadpoles (25) or salamander larvae (3); 72% of these were published before 1957 and 48% before 1931. As part of a larger study on intestinal protozoan-amphibian larvae relationships, the ontogenetic acquisition of enteric protozoans by amphibian larvae was determined for the following species: Anura: *Hyla crucifer*, *Pseudacris triseriata*, *Rana sphenocephala*; Caudata: *Ambystoma opacum*, *A. maculatum* and *A. talpoideum*. Five specimens were collected every 12 h during the first week of feeding and every other day for the following two weeks. Smears of gut contents from anerior, middle and posterior gut sections were prepared with standard fixatives and stains for examination with a light microscope.

58

CARVER, WAYNE E. and ROGER H. SAWYER. University of South Carolina--Localization of Alpha and Beta Keratins in Reptiles.

The vertebrate epidermis is constituted in large part by keratin fibrous protein. There are two distinct molecular forms of keratins, designated as alpha and beta, which are the products of two large, multigene families. Reptiles and birds are unique among vertebrates, having both alpha and beta keratins in their epidermal tissues whereas all other animals have only alpha keratins. Many keratins are produced during development as a result of complex dermal-epidermal interactions. Localizations of keratins in the epidermal tissues of various reptiles shows that these interactions are region and tissue specific. We have used SDS-PAGE, indirect immunofluorescence, and immuno-electron microscopy to examine the localization of alpha and beta keratins in the epidermis of various reptilian species. The epidermis of the scales of squamate reptiles (lizards and snakes) has at least six distinct cell layers in the epidermis and a somewhat vertical distribution of alpha and beta keratins. Beta keratins are localized in the outer cell layers and alpha keratins in the inner cell layers. The beta keratins are also found predominantly in the outer scale regions while alpha keratins are evenly distributed through the inner and outer scale regions. The epidermis of the alligator has a pattern of keratinization similar to that of avian scutate scales. The outer scale region is entirely beta keratin and the inner scale or hinge regions are alpha keratins. The epidermis of turtles shows a variety of keratin patterns.

59

DODD, C. KENNETH, JR. U.S. Fish and Wildlife Service--Movements and habitat use by the flattened musk turtle, Sternotherus depressus.

The flattened musk turtle, *Sternotherus depressus*, is a small aquatic turtle (adults <120 mm CL) endemic to the Warrior Basin in northern Alabama. 13 adult turtles (7 M;6 F) were fitted with radio transmitters and followed from 4 to 40 days (N=168). Turtles moved from 0-460 m overnight, though movements >30 m were unusual. Neither local nor long distance movements appeared influenced by weather variables. Males moved 81 of 118 nights (68.6%) and females 25 of 50. Males generally moved greater distances than females ($\bar{x}$ = 31.2 m, N = 81; $\bar{x}$ = 19.2 m, N = 25), though there were exceptions. Individuals overlapped in terms of movements and cover site selection, with no evidence of territoriality. Cover sites included rock crevices. under rocks, logs, and root debris, and buried in mud; such sites were usually located within 4 m of the shore. Individuals seemed to prefer a particular cover site type and frequent the same site often. *S. depressus* appears to remain in a small area most of the time, with occasional long movements the purpose of which remains unknown.

60

DODD, C. KENNETH, JR. U.S. Fish and Wildlife Service--Basking in the flattened musk turtle, Sternotherus depressus.

Basking has been reported in a number of kinosternid turtles, though until recently it has been considered rare in the flattened musk turtle, *Sternotherus depressus*. While conducting an ecological study of this species in northern Alabama, it was apparent that numbers of turtles were out of water, though it was conjectural whether they were thermoregulating; 67 such instances were noted, and included hatchlings, juveniles, and adults. Basking platforms included branches (20), logs (17), rocks (13), a rock face (1), and land (2). Platform width and height above water, and depth of the water were measured; no specific correlations were noted except that turtles preferred platforms over deeper (>450 mm) water. Most turtles were in direct sun (78.6%), were alert (66.7%), and appeared to be sick (60.6%). Cloacal temperatures (N=8) ranged as high as 33.1 C. These data support basking as thermoregulatory in this species. Basking was predominantly observed at the major location (65 of 67 observations) where sick turtles were collected thus supporting the suggestion of Mount (1981) that basking may be associated with sickness in this species. The presence of disease in a large population of *S. depressus*, a candidate for federal protection, is cause for concern.

61

MARION, KEN R.,[1] FLORA M. LOVE,[1] WILLIAM A. COX,[2] and CARL H. ERNST.[3] University of Alabama at Birmingham,[1] Marion Military Institute,[2] and George Mason University[3]--Food habits of the flattened musk turtle, Sternotherus depressus.

The flattened musk turtle, Sternotherus depressus, is restricted to permanent streams in the Black Warrior River Drainage of north central Alabama. In recent years habitat degradation has reduced or eliminated many local populations, and the species is currently proposed for federal protection. In the course of a study evaluating population levels throughout the turtle's range, a dietary analysis by examination of feces was performed in order to further define unknown aspects of its natural history and biology. Using weight or volumetric displacement, approximately 70% of the fecal content was snails and approximately 12% bivalves. The remainder consisted of crayfish parts, insects and plant material. Though there are limitations to dietary analysis by fecal content, the importance of snails and bivalves to the dietary requirements of S. depressus is evident. Food abundance was also quantified at several sites and the possible correlation of food levels with population densities is examined.

62

STUART, MICHAEL D. AND GROVER C. MILLER. North Carolina State University--The ecology of the eastern box turtle, Terrapene c. carolina, (Chelonia: Emydidae) in North Carolina.

One hundred and four eastern box turtles were collected in North Carolina as part of a study on helminth parasites. Baseline information was collected on host weight, shell size, sex and age structure, seasonal distribution, reproduction, and food habits. Stomach content analysis showed adult box turtles to be more carnivorous and insectivorus than indicated by previous reports. Although incidental to the parasite survey, these data significantly add to the available body of information on the ecology and life history of this common reptile.

63

GIBBONS, J. WHITFIELD. Savannah River Ecology Laboratory--Revelations of long-term research on long-lived turtles.

Turtles have two life history characteristics that set them apart from most other animals: (1) they live for many years and remain reproductively active; (2) they delay maturity for several years. One consideration in studying long-lived species is that individuals must be studied for a long time before certain questions can be addressed effectively. A mark-recapture study of more than 20,000 freshwater turtles has revealed information about this group of reptiles that is normally difficult to acquire. Evaluation of life history theories concerned with determination of the relationship between reproductive output and age of the individual has been possible by having older known-age females in study populations. A critical examination of whether long-lived reptiles display indeterminant growth patterns has also been possible. The determination of actual (rather than estimated) sex ratios of cohorts among different populations has permitted a different perspective of temperature-dependent sex determination through examination of known-age adult populations. Large sample sizes of older, known-age individuals has allowed the construction of life tables and comparative survivorship curves for males and females of these long-lived species.

64

CLAIBORNE, JAMES B. Georgia Southern College--Acid-base regulation in marine teleosts: a limitation to euryhalinity?

Teleosts (and most other vertebrates) maintain a plasma NaCl concentration of about 1/3 seawater. Thus, marine fish must deal with a constant diffusive gain of salts, while freshwater fish must actively compensate for a net loss of NaCl. Some species of teleosts (euryhaline) are able to move between waters of different salinities, while others (stenohaline) are restricted to waters with a more constant [NaCl]. Fish utilize the gills as the site of ion exchanges (Na^+/NH_4^+, Na^+/H^+, and Cl^-/HCO_3^-) to govern both salt and acid-base movements between the blood and external milieu. As a seawater adapted fish is exposed to brackish or fresh water, both ion and acid-base balance may be impinged. To test the effects of salinity alterations on these parameters, stenohaline long-horned sculpin (Myoxocephalus octodecimspinosus) were subjected to a serial dilution of the ambient seawater, while both internal acid-base status, and net ion transfers were monitored. Plasma pH, P_{CO_2} and [HCO_3^-] were all effected, as a mild respiratory acidosis (an increase of ~2 torr) was compensated by a 50% elevation in plasma [HCO_3^-]. A large net efflux of HCO_3^- to the water (~6 mM/Kg - probably of intracellular origin) was concurrently observed, and the fish were unable to survive below iso-osmotic levels (~150 mM NaCl). Clearly, sculpin cannot cope with the dilution stress, perhaps because of intracellular pH imbalances. It remains to be seen whether this response is involved with an active gill exchange mechanism, or if passive diffusional transfers are implicated. However, these data are preliminary evidence that the ability to maintain acid-base homeostasis may be a limiting factor in hypo-osmotic survival.

65

KORMANIK, GREGG A. University of North Carolina at Asheville--Uterine conditions and acid-base status of prenatal pups of the dogfish, Squalus acanthias.

Prenatal dogfish pups have a gestation period approaching two years. During the latter portion of gestation pups live in a uterine solution resembling sea water, at least with respect to the major ions. However, this sea water has an unusually low pH (ca. 6), high PCO_2 and very high ammonia concentration, approaching 22 mM. Nevertheless, blood of the mothers and pups is not significantly different with respect to pH, Total CO_2, Na and urea. Pup blood PCO_2 was slightly lower and ammonia significantly higher than that of the mother. To examine the time course of the establisment of these conditions, fresh sea water was introduced into the uterine horns of pithed dogfish from which the pups had been removed. Within 24 hours, sea water pH dropped from 8.2 to about 6, Total CO_2 dropped from 2.1 to 0.2 mM and the PCO_2 increased. However, after nearly 70 hours, uterine sea water ammonia was only about 7 mM, indicating that much more time was needed to establish ammonia levels seen in fresh-caught pregnant females. Acidification of the uterine sea water would serve to trap ammonia as well as protect the pups from toxic levels of NH_3. But why is ammonia accumulated when it might be easily flushed from the uterine horns with fresh sea water? The role of this accumulated ammonia in nitrogen metabolism of the pup is currently under investigation. (Funded by NSF DCB-8502251 and UNCA Intramural grant)

66

Young, Carolyn S. and John W. Harris. Tennessee Technological University--The effects of temperature stress on isozyme banding patterns in channel catfish, Ictalurus punctatus (Rafinesque).

An investigation was conducted to determine the effects of temperature stress on isozyme banding patterns in channel catfish. The catfish were acclimated at 20 C and divided into three groups. One group was placed in 37 C water and another in 4 C water. The third group was left in 20 C water to serve as the control group. Blood samples were collected from the experimental fish before they were subjected to stress. Blood and tissue samples were obtained from all three groups of fish following the stressing regimen. All collected blood and tissue samples were subjected to horizontal starch gel electrophoresis followed by selective staining to obtain isozyme banding patterns for lactate dehydrogenase and creatine kinase. For each group, the patterns observed for serum before and after stress were compared with each other and with the patterns observed for the control fish. For tissue samples, the patterns for stressed and control fish were compared.

67

HINTON, T. G.[1], F. W. WHICKER[2], J. E. PINDER, III.[1] Savannah River Ecology Laboratory[1], Colorado State University[2] --Temperature effects on the kinetics of radium and strontium in pond sliders.

Laboratory experiments were conducted on the kinetics of radium-226 and strontium-85 in pond slider turtles (Pseudemys scripta) as a function of two temperature extremes. One group (n=21) of turtles was kept at 28 ± 3°C and the other group (n=18) at 18 ± 3°C. All animals received 3.7 mBq each of Ra and Sr via oral gavage. Time series whole-body measurements were taken of the live animals with a Germanium semiconductor detector. The curve of activity vs time was well represented by a two-component exponential. A significant increase in the long-term retention of both isotopes occurred at the lower temperature. Sr had a significantly longer biological half-time than Ra in the turtles maintained at 28°C. This difference was not as observable at 18°C. The data also suggest the possibilities of different retention patterns as influenced by age and sex of the animals.

68

DECOURSEY, PATRICIA J. University of South Carolina--Circadian photoentrainment: photic thresholds for phase-shifting relative to habitat for 4 species of nocturnal rodents.

Field and laboratory studies were conducted to determine the relationship of light threshold for delaying the start of locomotor running activity relative to dusk light intensities at different seasons in natural forest and desert habitat for the flying squirrel (Glaucomys volans) and the deermouse (Peromyscus leucopus) from forest sites, as well as for the kangaroo rat (Dipodomys merriami) and the golden hamster (Mesocricetus auratus) from desert sites. In recording cages in the laboratory with light-dark schedules, all 4 species synchronized the onset of activity to the start of darkness. The threshold for delay resetting of the circadian pacemaker was determined by constructing intensity-response (fluence) curves; animals free-running in continuous darkness were exposed to single 15-min pulses of monochromatic green light (500 nm) of specific intensities at circadian phase point CT 13 for hamsters or CT 12 (onset of locomotor activity) for the other 3 species. Threshold for desert hamster and kangaroo rat approximated civil twilight intensity of open desert habitats, while for 2 woodland species threshold was about 10^3 lower, matching civil twilight intensity in a heavily shaded forest habitat. Fluence curves for all 4 species suggest novel circadian photoreceptors with much higher thresholds than imaging rod values. Continuous automated recordings of light intensity in forest and open unvegetated areas were made for 3 seasons of the year under clear and cloudy sky conditions to delineate daily light profiles for each habitat. Circadian photic thresholds appear adapted to allow initiation of nocturnal activity with minimal risk of predation.

69

VARNEY, DAN R,[1] MICHAEL NDEFRU,[1] SANFORD L. JONES,[1] MALCOLM R. SIEGEL[2] and PANLOS ZAVOS.[2] Eastern Kentucky University[1] and University of Kentucky—The Effect of the Fescue Endophyte on the Rat Estruous Cycle.

It has been suggested that animals grazing on endophyte-infected tall fescue may not be able to reproduce at normal levels. The rat is used as a model to study this problem. Young Sprague-Dawley female rats were fed tall fescue seed infected with the endophytic fungus, Acremonium coenophiatum (Epichloe typhina) to determine the effect of the endophyte on reproductive potential of the females and to assay for changes in certain glands and organs in the rats. Three sets of rats were run and three sets of data were collected. The diets consisted of mixtures of 100% infected fescue seed, uninfected fescue seed and Purina rodent chow. All feeding materials were ground in a Wiley Mill. Daily vaginal cytology showed that females eating 40-50% infected diet ceased their estruous cycles and were unable to reproduce. Autopsy of the animals revealed changes (percent body weight) in thymus gland, thyroid gland, adrenal gland, ovaries, uterus and lungs.

70

Hem-Lee, Hugh C., and Dan R. Varney, Eastern Kentucky University - - Physiological Effects of Tall Fescue Toxicity on Mammalian Internal Organs.

In order to test the physiological effect of the fescue endophyte, Acremonium coenophialum (Epichole typhina), 40 female Sprague Dawley rats were assayed. The subjects were fed a mixture of 50% purina rat chow and 50% fescue seed with varying levels of endophyte contamination in the seed. Ultimately, five treatment groups consisting of 0%, 5%, 10%, 20% and 40% endophyte in total food were developed. Eight sugjects were randomly assigned to each treatment group and they were fed adlibitum for 4 weeks. Once per week the weight of food consumed as well as the subjects body weight were recorded. After 4 weeks the animals were sacrificed and the ovaries, uterus, adrenals, thymus, thyroid, lungs, brain and pituitary were dissected out and weighed.

The mean weight of the various organs were obtained for each test group and an analysis of variance performed. Total body weight, thyroid, and ovary weights showed significant differences among group means at the 95% confidence level. The mean weights for the brain, pituitary, thymus, lungs, adrenal and uterus showed no significant differences among the groups. Preliminary indications suggest that the groups that were fed higher concentrations of endophyte are the sources of variation.

71

KAPPES, CARL J,[1] DAN R. VARNEY,[1] SANFORD L. JONES,[1] MALCOLM R. SIEGEL[2] and PANLOS ZAVOS.[2] Eastern Kentucky University[1] and University of Kentucky—Reproduction and Lactation in Laboratory Rats Fed Endophyte-Infected Fescue Seed.

Acremonium coenophialum infected fescue seeds were fed to laboratory rats to measure the effect of toxic fescue on livestock reproductivity and lactation. Separately caged female rats were fed diets of zero, 10, 20, and 40% infected fescue. There was also a 40% limited intake control. Rats were mated after 3 weeks and autopsied for endocrine gland weights after the pups were weaned. No pups were produced by females on 40% endophyte. The 40% limited intake control had 75% of the rats produce pups but were unable to nurse the pups to maturity. Weight gains for all treatment litters were significantly less than for control litters. These results show the fescue endophyte to play a part in decreased reproduction and lactation in laboratory rats.

72

MORTON, DAVID and HUGH HALL. Frostburg State College and Wright State University--Blood urea levels and urease positive Enterobacteriaceae in the common vampire bat (Desmodus rotundus).

Four vampire bats were allowed to feed ad libitum on citrated bovine blood for 2 hours. After the blood meal was withdrawn, a blood sample was drawn from the lateral wing vein of each bat. Three additional samples were taken over the next 21.5 hours. Urea nitrogen levels were measured in the plasma obtained from each sample using the diacetyl monoxime method. During the first 2 hours, urea levels were 232 ± 31 (mean ± standard deviation) mg/100 ml blood. Urea levels rose to 294 ± 38 mg/100 ml blood at 2.5 to 4.5 hours and 303 ± 59 mg/100 ml blood at 10.5 hours. Urea levels then fell to 264 ± 44 mg/100 ml blood at 15 hours, 223 ± 65 mg/100 ml blood at 17 hours and 223 ± 65 mg/100 ml blood at 19.5 to 21.5 hours. An ANOVA and Duncan's multiple range test showed that the value at 2.5 to 4.5 hours was significantly different ($p<0.05$) from those obtained during the first 2 hours, at 17 hours and thereafter. Likewise the value obtained at 10.5 hours was significantly different from those obtained during both the first and last 2 hours. Specimens were collected from the feces and recta of the four vampire bats. Pure cultures of bacteria were isolated, tested for urease activity and where possible identified using the API 20E system. Most bacteria were urease positive. All specimens contained Proteus vulgaris. Other urease positive bacteria included Klebsielleae oxytoca and Morganella morganii. There was at least one additional unidentified gram negative, urease positive bacterium.

73

PEET, ROBERT K. and NORMAN L. CHRISTENSEN. University of North Carolina, and Duke University -- Hardwood forests of the North Carolina piedmont: variation in space and time.

Mature hardwood forests were investigated as part of a larger study of forest succession. Multivariate statistical methods were used to identify compositional trends in vegetation data, and to relate those trends to environmental variables. Composition of both the tree and herb layers was found to correlate closely with soil chemical and physical properties predictable from knowledge of the underlying rock types. Soil calcium ranged from 10 to 3000 ppm, and together with magnesium, and pH correlated strongly with the dominant ordination axes. In addition, clay mineralogy, soil moisture, soil texture, calcium:magnesium ratio, and soil phosphorus all correlated strongly with major gradients in forest composition. Herb and shrub species diversity were closely correlated with soil calcium, pH, and P. Tree species composition and diversity were somewhat less strongly related to substrate, and more strongly related to disturbance history. The results suggest a much tighter linkage between forest composition and geology than has previously been apparent from the published literature for the region.

74

GRELLER, ANDREW M. Queens College, CUNY--Critical physiognomic attributes of forest zones in eastern North America.

I consider here only the arborescent strata on mesic uplands in the vast region dominated by the Boreal Flora, east of the central grasslands. The following physiognomic features appear to be critical for characterizing forest zones: evergreenness vs. deciduousness in angiosperms, presence or absence of evergreen needle-leaved conifers, and of tuft-trees. Floristic criteria are required to draw boundary lines between zones. I propose that five zonal types be recognized; critical physiognomic features are in parentheses: (1), Evergreen Angiosperms (both evergreen dicots and monocot tuft-trees dominate); (2), Deciduous Dicots, Evergreen Dicots, Evergreen Conifers (deciduous dicots dominate, but evergreen dicots and evergreen conifers are canopy constituents; (3), Deciduous Dicots (generally deciduous dicots dominate, but evergreen conifers may be local dominants; (4), Evergreen Conifers, Deciduous Dicots (mosaic of evergreen conifer stands, deciduous dicot stands, and mixed stands); (5), Evergreen Conifers (evergreen needle-leaved conifers are nearly ubiquitous). These proposed types are discussed in comparison with forest associations previously recognized on floristic criteria by Braun and by Quarterman and Keever. The types are then classified using the Zonobiome system of Walter.

75

JONES, STEVEN M., RICHARD K. MEYERS, and ROBERT ZAHNER. Clemson University--A physiographic classification of forest lands of South Carolina.

The objective of this project was to classify physiographic land patterns into units having significance to forest productivity assessment. The attempt was to make categorical interpretations in a primarily qualitative sense based on attributes of the entire physical environment. The character, arrangement, and relationships of the geology, soils, vegetation, topography, and climate were considered. The physiographic approach permitted integration of these factors as affecting the distribution of forest communities within South Carolina. In addition, assessment in terms of forest tree growth potential and species site suitability was possible. Utilizing a mosaic of recent black and white Landsat satellite images at a scale of 1:500,000, seven major physiographic provinces were delineated on the basis of major landform patterns. These were further classified into 23 regions and subregions. The classification has a wide range of applications in resource management, planning and policy, as well as research and teaching.

76

METHVEN, ANDREW S. University of Tennessee, Knoxville--The fungus flora of Highlands, North Carolina and vicinity.

The diversity of ecological habitats and vascular plant communities in the geographic area surrounding Highlands, North Carolina is partially reflected in the large number of taxa of fungi collected in the area. Despite the long and distinguished history of mycological research conducted through the Highlands Biological Station by W.C. Coker, L.S. Olive, and L.R. Hesler, only three partial checklists of fungi from the Highlands area have been published. While in residence at the Highlands Biological Station during summer, 1984 and 1985, nearly 1000 specimens, including several new records for the southeastern United States, were collected. Advances in systematic mycology, and nomenclatural revisions in the last ten years, warrant the preparation of a comprehensive checklist of Highlands fungi. A computerized database of Highlands fungi has been prepared which incorporates previous checklists, the authors personal collections, and published or unpublished reports of fungi by mycologists who have collected in the vicinity of Highlands. Taxonomic and nomenclatural notes for each taxon are included in the database along with the author, collector or reference, collecting locality, and data on vascular plant associates. The database provides baseline information around which future mycological research in the southern Appalachians can be planned and a more thorough understanding of the geographical and ecological distribution of fungi in the southern Appalachians.

77

BIAN, LING. University of Georgia--Modeling Vegetation-Climate Relationships in China.

There is remarkable similarity between the vegetation geography of China and that of the USA, except that China has no west coast. Recent studies suggest that environmental-envelope models may be able to predict Chinese vegetation fairly well using mainly basic climatic variables. In order to develop such a model, 70 climatic data sites in and around China were selected to represent the main climatic and vegetation regions. Statistical procedures suggested some important climatic factors and corroborated theoretical expectations and some other models. These procedures provided initial estimates of the environmental envelopes; these were refined further by trial and error. The model was checked by predicting the "natural" vegetation at the remaining 150 Chinese stations for which monthly climatic data are available. Such models are useful for comparing Chinese plant-environment relationships with those elsewhere and for suggesting potential vegetation and vegetation dynamics in areas with little remaining natural vegetation.

78

BOX, ELGENE O. University of Georgia--Vegetation Science in East Asia and the Southeastern USA.

East Asia, the east side of the other large Northern Hemisphere land mass, is that part of the world most similar in climates, soils, and vegetations to eastern North America and the Southeast in particular. General similarities and differences are briefly summarized. Perhaps more interesting are other aspects of vegetation science, including biogeography, evolutionary history, environmental relationships, vegetation structure and dynamics, and productivity, as well as substitute vegetations and potentials for conservation, revegetation, and landscape architecture/ecology. East Asia extends further south than eastern North America, has somewhat greater species richness, and is more evergreen. Nevertheless, secondary vegetation is often deciduous, and form diversity may be greater in North America. Longer histories of major human disturbance in East Asia have produced stable disclimax communities not yet found in North America. Most evergreen leaves are harder, while softer leaves are usually deciduous; why has East Asia developed notable exceptions? US landscaping seems to prefer exotic species, but revegetation projects in Japan have had great success with native species. Recent regional comparisons have focused mainly on biogeography and evolution, but many general questions remain, some with perhaps useful practical implications.

79

FUJIWARA, KAZUE. Yokohama National University--Potential and actual vegetation regions in Japan.

Japan stretches from about 20 to 45^0 north latitude, comparable to eastern North America from Cuba to Prince Edward Island. An evergreen broad-leaved forest region covers roughly the southern half but has been converted almost completely to secondary deciduous forests, evergreen coppice forests, vast conifer plantations, and some grasslands. It remains, however, the historic homeland of the Japanese people and still contains all large cities except Sapporo. A summergreen broad-leaved forest region covers northern Japan and higher elevations in the south, followed upward and on Hokkaido by a coniferous forest region and small areas of alpine meadows. On Honshu, the drier Pacific forests differ considerably from those facing very heavy snowfall along the Sea of Japan. The vegetation of smaller islands also differs significantly, with southern islands more resembling Korea, eastern China, or Southeast Asia. There are striking vegetation similarities between Japan and eastern North America but also interesting differences, due to Japan's archipelago structure and the extremely maritime climates. There are many opportunities for studying evolutionary and recent vegetation history and island biogeography. Clues for studying the original vegetation remain around shrines and temples, old farmhouses, and some residences. These help determine the current potential natural vegetation, the basis for revegetation efforts.

80

Fralish, James S. Southern Illinois University, Carbondale. A site-specific approach for predicting potential stand composition in the Shawnee Hills Forest of Illinois.

Multiple regression models were developed for predicting stand composition index (CI) from site factors in the Shawnee Hills. A CI value for 46 undisturbed, compositionally-stable stands was obtained by multiplying a species relative basal area by its adaptation value. Adaptation values were assigned based on the position of a species maximum basal area value along a stand basal area gradient. A value of 1.0 was assigned to Juniperus virginiana which dominated low basal area stands (<15 m^2/ha). Acer saccharum was assigned a value of 10 because it dominated high basal area(>25 m^2/ha) stands. Values of 2.3, 5.4, and 8.0 were assigned to Quercus stellata, Quercus alba, and Quercus rubra, respectively. Three models were developed to predict CI. The best model accounted for 97 percent of the variation in CI and contained soil available water capacity, slope position, aspect, and distance to the opposing slope as predictor variables. The models were validated using an independent data set and then used to predict CI in successional stands and on highly disturbed sites such as old fields and pine plantations. Predicted CI was then decoded into species components. A biological interpretation was developed based on soil water storage and the influence of other site factors on evapotranspiration loss.

81

ADAMS, HAROLD S. and STEVEN L. STEPHENSON. Dabney S. Lancaster Community College and Fairmont State College--Ecological study of old-growth red spruce stands in the mid-Appalachians.

Few studies have dealt with mid-Appalachian red spruce forests, especially old-growth stands. Yet these isolated high elevation forests are of ecological interest since (1) they are located in a "tension-zone" for their distribution and (2) a rather severe decline of red spruce has been reported elsewhere, especially in the northeast. Increment growth cores were collected from dominant and co-dominant red spruce (Picea rubens Sarg.) trees in three old-growth stands in central West Virginia (Shavers Mountain in Randolph and Tucker Counties and Cheat Mountain in Pocahontas County) and one stand located in southwestern Virginia (Salt Pond Mountain in Giles County). Quantitative data also were obtained on composition and structure of all strata of vegetation in these stands. Mean ages (±SE) of sampled stands based upon cored trees ranged from 164 ± 18.4 to 201 ± 9.6 yrs; age of the oldest tree was 368 yrs. Dendroecological (tree-ring) analysis showed a marked decline in growth of trees at most sites during the late 1800s followed by recovery to the previous rate of growth within two decades. This growth-trend decline generally coincided with a period of extensive mortality of red spruce reported to have occurred in central West Virginia. Basal area of trees larger than 2.5 cm DBH ranged from 35.4 to 46.1 m^2/ha, with the highest value recorded in the Giles County, VA stand. These figures are considerably less than those recorded at earlier dates (e.g., 1937, 1951, 1966) for similar old-growth stands of red spruce in the Appalachians, which suggests that a general decline has occurred over the last half-century.

82

CLEBSCH, EDWARD E.C. and GARY L. WALKER. University of Tennessee, Knoxville--Recent discoverires or range extensions of vascular plants associated with disjunct arbor vitae (Thuja occidentalis L.) in the Southeast.

Cypripedium reginae, Rhamnus alnifolia, and Pachystima canbyi are strictly associated with Thuja. Rhamnus lanceolata, Spiranthes lucida, Zigadaenus glaucus, Taxus canadensis, and Smilacina stellata, rare in the range or rare with Thuja, occur with it and beyond. All of the above (save Taxus) are calciphiles. Acer spicatum outside the mountains is mostly associated with Thuja. Tsuga canadensis and Rhododendron maximum, normally acidophilic, occur with Thuja frequently. Numerous literature references to native Thuja in North Carolina remain undocumented by specimens or by field sightings by living botanists.

83

SMITH, MARY M. Clemson University--A floristic study of Palmetto Islands Co. Park, Charleston Co., S.C.

Palmetto Islands Co. Park consists of approximately 1000 acres of saltmarsh and highland on the Wando River north of Mt. Pleasant, S.C. There are a number of small islands in the marsh that are covered with subclimax maritime forest dominated by Sabal palmetto and Pinus taeda. Hardwood (Liquidambar styraciflua - Quercus falcata) and climax maritime (Quercus virginana) communities are also present in smaller amounts. A two year study of the vascular vegetation in the park was begun in 1984. More than 300 species, representing 85 families, were found. About 50 of these species were county records. The forest communities were sampled in order to determine importance values and all the plant communities in the park were described.

84

PARR, PATRICIA DREYER, AND RHONDA K. JONES. Oak Ridge National Laboratory and Fort Valley State College--Initiation of long-term research on a rare plant population on the Oak Ridge National Environmental Research Park.

The National Environmental Research Park at Oak Ridge, Tennessee is one of five preserves established by the Department of Energy to provide protected land areas for research and education in the environmental sciences and to demonstrate the environmental compatibility of energy technology. The Oak Ridge National Environmental Research Park has established several natural areas to protect critical habitats of rare plant species on the Oak Ridge Reservation. Protection of these areas is the initial objective, but the species must also be studied to determine beneficial management strategies. For example, the largest population of the endangered Delphinium exaltatum in Tennessee is located on the Oak Ridge Reservation. Part of this population was inadvertently bulldozed in 1983. This area is now a protected natural area, and permanent plots have been established for long-term data collection. A 45- by 450-m sampling system was established, with transect lines 50 m apart, and 100 plots were sampled, using a 1-m^2 ring. Information was collected on the number of D. exaltatum plants (adult, young, seedling), height of the tallest plant, habitat type and the percent cover by D. exaltatum. Seedlings comprised over 50% of the plants recorded. An inventory was made of other species present. Based on a previous study of the area and the initial data collection, the population appears to be recovering from the bulldozing impact. Information from this long-term study will be used in determining management strategy for the area and in long-range land-use planning. Research sponsored by Office of Health and Environmental Research, U.S. Department of Energy, under contract No. DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

85

MASSEY, JIM, CINDY AULBACH-SMITH, JIM MATTHEWS, and JIM DOYLE. University of North Carolina-Chapel Hill, University of South Carolina, University of North Carolina-Charlotte, and Thomas Aquinas College--A forum for herbarium curators and users: "computers in the herbarium". Brief presentation and open discussion on use of microcomputers and minicomputers ranging from herbarium record keeping, generation of specimen and annotation labels, to managing distribution, locality and collector data, and exsiccatae. Participants are urged to bring examples of their output and sources of software and selected supplies.

86

HARRISON, FREDERICK W.,[1] NANCY W. KAYE,[2] and GORDON I. KAYE.[2] Western Carolina University[1] and Albany Medical College[2]--The "dermal membrane" of the freshwater sponge, Eunapius fragilis (Leidy 1851). The "dermal membrane" of Eunapius fragilis is structurally complex. It consists of regions exhibiting numberous ostia and porocytes which overlie vestibules and of other regions surfaced almost entirely by exopinacocytes. Between the exopinacocyte and endopinacocyte layers of the "dermal membrane" is a well-defined fibrillar mat which resembles in many respects, a fibrous lamina. Exopinacocytes are in intimate contact with the fibrous meshwork but appear capable of movement upon it. A population of ameboid cells is present upon the free surface of the "dermal membrane." These ameboid cells interact with "foreign" structures such as pollen grains and protozoans. In many cases the ameboid cells deposit fibers upon the foreign body in what appears to be a primary tissue response. Our observations with LM histochemistry and SEM currently are being supplemented by STEM studies. F.W.H. was supported by a fellowship from the Edmund Niles Huyck Preserve, Inc., Rensselaerville, NY.

87

HARRISON, FREDERICK W. and BARRY G. WARNER. Western Carolina University and University of Waterloo--Fossil freshwater sponges from Western Canada: An overlooked group of Quaternary paleoecological indicators. Analyses of fossil spicules and whole gemmules of freshwater sponges were performed on early Holocene sediments collected from a bog lake on eastern Graham Island, Queen Charlotte Islands, British Columbia. Anheteromeyenia sp. dominated the fossil record, and lived with a less abundant population of Spongilla lacustris. These species indicate shallow, standing, or slow-moving waters that were probably circum-neutral to slightly basic, with moderate to low carbonate alkalinity, high specific conductance, silicon, and color. The data corroborate interpretations made from fossil pollen and macrofossils of aquatic plants. Spicular components and whole gemmules of freshwater sponges often are well-preserved, abundant in certain sediments, and identifiable at the species level, which makes sponges a valuable group of Quaternary paleoecological indicators.

88

MA YUN TAO. and FREDERICK W. HARRISON. Western Carolina University--Cytochemical Examination of Oocyte Development in Freshwater Sponges. Freshwater sponges, Eunapius fragilis (Leidy) and Ephydatia fluviatilis (Linneaus), collected, respectively, in July in Albany,NY area and in February-March in New Orleans,LA, were engaged in oogenesis. Developmental patterns were similar in the two species. Early stages of oocyte growth involve assimilation of reserve materials directly from the mesohyl of the sponge. During this period of enhanced transcriptional activity, oocytes exhibit high levels of cytoplasmic RNA, prominent nucleoli, and extended chromatin but contain few cytoplasmic vitelline platelets. In the second phase of oogenesis, trophocytes, "nurse cells," containing cytoplasmic reserve inclusions migrate to the surface of the oocyte. Following phagocytosis or encapsulation of trophocytes by the oocyte, the trophocytes persist and transfer macromolecules into the ooplasm. In this period of accelerated growth, leading to oocyte maturity, the oocyte synthesizes and accumulates considerable large and small cytoplasmic vitelline platelets. Meiosis was not observed.

89

BISBEE, JOHN W.[1], JOHN C. FRANCIS[2], and FREDERICK W. HARRISON[3]. Lenoir-Rhyne College[1], University of New Orleans[2], and Western Carolina University[3]--Development of freshwater sponges from reduction bodies grown in culture. Freshwater sponges degenerate to form reduction bodies in the presence of unfavorable environmental conditions. During formation of these bodies, the sponge withdraws centrally from its skeleton, forming a spherical structure devoid of canal systems that is composed of ameboid cells surrounded by an epithelium. Upon return of more favorable conditions, hypothetically, a complete sponge may be produced from the reduction body. We have tested that possibility by culturing sponges (Ephydatia fluviatilis), inducing reduction body formation (by lowering the pH from 7 to 6), returning the reduction bodies to normal conditions, and observing the development (regeneration) of sponge tissue microscopically. Our observations suggest the following series of events: The reduction body produces a thin (perhaps single cell) layer in a day or two that spreads over the culture surface; the layer thickens due the accumulation of cells and forms an epithelium by three days; in five days the sponge tissue contains canal systems and skeletal components (megascleres). Thus, the main elements of mature sponge tissue have been produced in culture from reduction bodies.

90

SMITH, J. DAVID. Western Carolina University--Cellular responses to BSA-FITC and wound healing in the body wall of the slug, Deroceras laeve.

Histochemical examination of the body wall of the slug Deroceras laeve (Gastropoda: Pulmonata) reveals that the integument is highly modified for secretory function. A variety of glandular types, including unicellular glands, are positioned in a bed of areolar connective tissue. All glands are lined with, or either empty via ducts through a simple columnar epithelium. Ciliated epithelial pits are present ventrolaterally. The relative abundance of areolar connective tissue in the integument suggests that the slug is an excellent vehicle for studies of wound healing and macrophage responses to immunologic challenge.

91

HANLEY, ROBERT W. RMT, Inc. Greenville, SC--Biogeography and distribution of the Pleuroceridae (Mollusca:Gastropoda) in the Warrior River Basin, Alabama.

Pleurocerid snails are the most abundant freshwater gastropods inhabiting the Warrior River system, often paving the bottoms of rivers and streams. The fauna, however, is depauperate with respect to the Tennessee River system to the north and the Alabama - Coosa - Cahaba River system to the east. The species assemblage includes two species of Leptoxis (=Anculosa), two species of Pleurocera and ten species of Elimia (=Goniobasis). For the most part these snails are found above the fall-line, with only one species of Elimia (E. cylindracea) having been collected below the fall-line in recent history. Species found in headwater streams are most closely related to the Tennessee River fauna, while species from the middle and lower reaches of the Warrior River have affinities with the Alabama - Coosa - Cahaba River fauna. Clearly, pleurocerids invaded the Warrior River from the north and east. Nonetheless, this species assemblage has been isolated sufficiently long to allow for endemic speciation to have occurred. Only one species of this group has been extirpated from the Warrior River in recent history.

92

HEARD, WILLIAM H. Florida State University--Brooding patterns in freshwater mussels.

Two patterns of brooding embryos and subsequent larvae in all four or in only two of the parental demibranchs were described 75 years ago and often have been used to characterize higher taxa of unionoid bivalves. In one, called tachytixis, preparasitic development is completed in about one month in the Nearctic summer; in the other, termed bradytixis, brooding lasts for most of the year, except for a period in the summer. More recent findings have revealed several additional patterns, including three- and six-month cycles in unexpected seasons. Comparison of cohabiting populations of different species indicates that some of the diversity in brooding habit is ecophenotypic, but some is not. Findings from immunological and electrophoretic studies suggest that the bradytictic pattern is homoplastic (a parallelism) and not "homologous" to tachytixis.

93

CHASE, KIMBERLY A. AND RONALD ALTIG. Mississippi State University--Breeding ecology of the green lynx spider (Peucetia viridans).

Seventy-seven egg-brooding female spiders were collected in northern Noxubee Co., MS from 3 - 9 October 1985. Characteristics of plants with spiders and a random sample of plants in the area, spider weight and cephalothorax length, egg case diameter and weight, and number of eggs/embryos were recorded. Spiders on goldenrod (N = 45; Solidago sp.) were always in the inflorescence at 84 - 100% of the plant height. Egg number (92 - 280) increased with an increase in egg case diameter (12.8±1.4 mm) and spider weight (17.7±3.7 mg) and cephalathorax length (5.9±0.5 mm). These data will be discussed relative to concepts on breeding biology and energy allocation.

94

OETINGER, LIYONABAH and RONALD ALTIG. Mississippi State University--Spots on moth wings: their positions and possible functions.

Moth wings are divided into several fields based on pigmentation. Often there is a "reniform spot" in the front wing, and similar spots are common in the hind wing; moths with these patterns vary widely in taxonomy, morphology, ecobehavior and relative development of the spot. In this preliminary study, measurements and categorizations were made from natural-scale photographs of 83 species of sphingid and saturniid moths. Variations in spot location were documented for the entire data set and selected subsets. The data will be discussed relative to possible behavioral functions.

95

CONNELL, MARY U. and ROBIN L. CANTERBURY. Appalachian State University--Nutrient loading and its effect on the composition and structure of the benthic algal community in the South Fork of the New River.

Nutrient loading and its effect on the composition and structure of benthic algal communities were examined on the South Fork of the New River where this shallow mountain stream receives the effluent from the Boone Sewage Treatment Plant. Two collecting sites were used to compare the differences in water chemistry and the algal communities upstream and downstream from the effluent outfall. Results of water analyses indicated that the river is receiving significant quantities of inorganic nutrients in the form of ammonia nitrogen and orthophosphate. On average the concentration of ammonia nitrogen was three and one half times greater while orthophosphate levels were ten times higher at the downstream site. The benthic algal community's composition and structure were also consistently different in the enriched section of the stream. Species richness was always higher at the control site. Standing crop biomass and species diversity fluctuated seasonally. However, results indicated that the benthic algal community at the downstream station experienced a decrease in species diversity that corresponded to an increase in nutrient concentrations from the sewage effluent outfall.

96

DE LA CRUZ, A.A.[1], C.T. HACKNEY[2], N. BHARDWAJ[3]. Mississippi State University[1], University of North Carolina at Wilmington[2], and University of Rajasthan--Temporal and spatial patterns of redox potential(Eh) in three tidal marsh communities.

The redox potential (Eh) of three marsh communities namely tall Spartina alterniflora, short S. alterniflora, and Juncus roemerianus was measured at various depths and seasons, and in the presence or absence of living vegetation. Eh was measured with platinum electrodes according to procedures tested in the laboratory which showed that equilibrium was attained after 15 minutes. In general, Eh of marsh soils (measured in millivolts) varied among marsh types (short Spartina < Juncus < tall Spartina), between vegetated and devegetated plots (devegetated < vegetated), with season (dormant < growing season), and depth (bottom < surface). Spatial variations in Eh appeared to be caused by the presence or absence of rhizospheric materials and temporal variations due to the activity or dormancy of plant root tissues. Living J. roemerianus roots affected the substrate by increasing Eh, but the mechanism did not appear to be oxygen diffusion from the roots.

97

DISTEFANO, ROBERT J.,[1] MARK C. LEWIS,[2] RICHARD J. NEVES,[1] and LOUIS A. HELFRICH,[1] Department of Fisheries and Wildlife Sciences, Virginia Tech[1] and Physiology Group University of Kentucky[2]--Effects of acute acid exposure to a species of freshwater crayfish.

Flow through toxicity tests were conducted to examine effects of reduced pH on populations of Cambarus bartonii bartonnii from high-elevation Appalachian streams. Concentrations of major hemolymph cations were determined utilizing atomic absorption spectrophotometry following acute exposure (96h) to the LC10 (pH 2.61). Hemolymph $[Na^+]$ appeared to decrease when compared to controls after 4 days. Levels of $[Ca^{++}]$, $[Mg^{++}]$ and $[K^+]$ in hemolymph from acid-exposed specimens were similar to those from control specimens. No significant changes were observed in exoskeleton (carapace) $[Ca^{++}]$ subsequent to 96h exosure to pH 2.46 to 2.96, but the molting process appeared to be inhibited by depressed pH. Possible ecological implications of acid deposition on crayfish are discussed.

98

BOWLING, J. W., J. J. ALBERTS, R. A. GEIGER, D. W. LUTKENHOFF, and J. E. PINDER. Savannah River Ecology Laboratory--Does the annual cycle of Cs-137 concentrations in lake waters result in an annual cycle of concentrations in largemouth bass, Micropterus salmoides?

The concentrations of Cs-137 in lakes with anoxic hypolimnions demonstrate an annual cycle with minimum concentrations in the spring and maximum concentrations in the fall. The cycle is driven by the release of Cs-137 from the sediments during periods of summer anoxia followed by redistribution of Cs-137 throughout the water column during fall turnover. To determine if the cycle of Cs-137 concentrations in Pond B, a 87 ha reservoir in South Carolina, affects the concentrations in largemouth bass (Micropterus salmoides), Cs-137 concentrations were determined in bass collected at monthly intervals from January, 1978 through January, 1979. Whole-body concentrations of Cs-137 were determined at each sampling period, and concentrations in muscle, liver and other tissues were determined for selected months. There was little evidence to indicate an annual cycle of Cs-137 concentrations in bass.

99

KELLY, MARY SAULS. Savannah River Ecology Laboratory, University of Georgia--Concentrations of cesium-137 in young bass and sediments: Effects of body size and location on bioaccumulation.

Reported influences on bioaccumulation of Cs-137 in freshwater fish include body size, and amounts of suspended solids and sediment type. Fingerling bass may function as top predators within localized areas of the littoral zone, and heterogeneous substrate conditions could contribute to variability in concentrations of Cs-137. Cs-137 concentrations in 198 .8-10 g largemouth bass, seined from 5 shoreline locations in Pond B, Savannah River Plant, S.C., had a range and mean of 41-126 and 78 pCi/g (wet wt) and were significantly different by location. Although there was a positive relationship, body size was not a useful predictor of Cs-137 in young bass (r^2=.233) but was a significant predictor (r^2=.7) when adult size classes were included (range of Cs-137 in adults: 69-295 pCi/g (wet wt)). Cs-137 concentrations in 78 sediment cores taken at seining locations ranged from 8-175 pCi/g (dry wt) and were also significantly different by location. Cs-137 concentrations in cores were positively correlated with percent organic matter and with silt+clay content. Analysis of remaining fish samples should allow assessment of how sampling date may affect variability in concentrations. Detritus in littoral zone sediments may be an important factor affecting localized inventories and bioavailability of Cs-137.

100

MALCOMB, C. DALE, RANDY D. TAYLOR, and DONALD C. TARTER. Marshall University--The use of STORET and the National Sanitation Foundation's Water Quality Index to develop a regionally adaptable index of water quality.

In 1974 the National Sanitation Foundation developed a water quality index (the WQI or NSFI) based upon chemical parameters, which demonstrated a high degree of accuracy in qualifying water conditions. The NSFI was subsequently used in many areas, where it was found that various adaptations were necessary to maintain accuracy. This study utilizes STORET (the EPA's Storage and Information Retrieval System) to adapt the NSFI for accurate use within West Virginia. Chemical parameters stored in this system were chosen through computer programs designed to indicate which parameters were necessary for accurate water quality analysis within West Virginia, and then to establish weighting factors for these parameters making it possible to incorporate them into the NSFI. The goal of this study was twofold: (1) to adapt the NSFI for accurate use in West Virginia, and (2) to establish a standardized method for adapting the NSFI to any region or state.

101

MEADOWS, JAMES A. and DONALD C. TARTER. Marshall University--Ecological assessment of benthic macroinvertebrates in the Cranberry River, Pocahontas County, West Virginia.

Evident differences in water quality over the length of the Cranberry River are reflected in the benthic macroinvertebrate community structure. Aquatic macroinvertebrates and various physical and chemical parameters were inventoried to allow comparison among sites. Quantitative samples from seven stations were collected seasonally. Biotic indices of community structure were derived to assess differences among sites and to describe overall stream quality. Additionally, benthos were classified into functional feeding groups to examine spatial shifts in macroinvertebrate trophic relations. Finally, multivariate discriminant analysis was used to show variation among all the parameters at seven stations.

102

PETTRY, DANIEL K. and DONALD C. TARTER. Marshall University--Ecological life history of the mayfly Baetisca carolina Traver in a West Virginia stream.

The ecological life history of the mayfly Baetisca carolina Traver was studied in Panther Creek, Nicholas County, West Virginia. Nymphs were primarily collected from a sand and small stone substrate. Length-frequency distributions indicate a one year (univoltine) life cycle. Male and female nymphs exhibited the greatest growth in April and July. Females exhibit a definite size superiority. Monthly foregut analysis indicates that nymphs are primarily detritivorous, with other components of the diet including diatoms and filamentous algae. Two colormorphs, light and dark, are present in the population. As nymphal size increases, a greater percentage of the population exhibits light body coloration. Multivariate discriminant analysis was used to separate B. carolina from the closely related B. berneri. Subimagos emerge in the field from mid-May through the end of August. A bimodal pattern of emergence was observed. Imagos emerged approximately 24 hours later. Direct egg counts ranged from 3271 to 5274 per female; the average was 4280. The correlation coefficient between fecundity and body size was 0.83.

103

ADKINS, M. D., D. A. SCHMIDT, and D. C. TARTER. Marshall University--Free fatty acids and lipid content of first and second year naiads of the stonefly Acroneuria carolinensis (Banks).

Fatty acid composition and total lipid content of first and second year naiads of the stonefly Acroneuria carolinensis were investigated. Relative total lipid content was higher in second year naiads. Fatty acid composition, determined by gas-liquid chromatography (GLC) of fatty acid methyl esters (FAMES), varied quantitatively between groups. The major FAME constituents of first year naiads were: C 18:1, C 18:2, and C 16:0. Second year major FAMES were: C 18:1, C 20:1, and C 22:0.

104

WYNNE, JOE and STEPHEN G. BOYCE. Duke University--Dynamo: A computer language which makes population dynamics simulation possible in the classroom.

The use of computer simulations in the classroom can reinforce many abstract concepts in Biology and Ecology. One important barrier to using models is the complexity of the computer languages that must be used and the difficulty of relating concepts to the syntax of the computer language. DYNAMO is an easy-to learn and easy-to-use system dynamics modeling language. Here, we give examples of how this educational tool will help solve problems in teaching Biology and Ecology at all levels. First, students can understand some of the more abstract concepts, such as tolerance, productivity, resilience and stability that may be difficult to grasp with other methods. Examples using DYNAMO can more fully describe the implications of such concepts. Second, students are able to determine problems to be addressed by research and management. Third, students can assess the result of the combined affects which exist in the environment of all populations. Program statements and output are illustrated and interpreted for classroom use.

105

J. Kenneth Shull, Appalachian State University. THE TREATMENT OF "UNEXPECTED" DATA IN THE GENETICS TEACHING LABORATORY.

When students perform experiments dealing with independent assortment using living organisms the results are not always as expected. For example, observed data frequently may vary from expected values based on a 9:3:3:1 ratio. This can be confusing to students and frustrating to professors who are trying to teach a simple genetic principle. A 9:3:3:1 ratio (0.5625 A_B_, 0.1875 A_bb, 0.1875 aaB_ and 0.0625 aabb) presupposes 3:1 ratios for both genes involved (0.75 A_, 0.25 aa; 0.75 B_ and 0.25 bb). If either or both of the recessive alleles is significantly more or less viable than its dominant allele, the expected number of flies in the four categories will probably vary significantly from the observed data, even though the genes are on different chromosomes and do assort independently. The hypothesis can be revised as follows: If the actual proportions of the phenotypes, which can be calculated from the data, are, for example, A_=0.8, aa=0.2, B_= 0.83, bb=0.17 (figures which are not unusual for students to find) then, if the genes are assorting independently, the expected proportions are A_B_=0.664, A_bb=0.136, aaB_=0.166 and aabb=0.034. When the expected numbers for the four categories are calculated the revised hypothetical expected data usually fit the observed data very closely, with P values calculated from the Chi-squared test being 0.80 or higher. This revision of the initial hypothesis and calculations of new expected results gives the student valuable insight of how the revision of a hypothesis is a part of the scientific method. Actual examples from student data will be presented and the calculations will be done.

106

CREEK, ROBERT. Eastern Kentucky University—An individualized approach to teaching a plant physiology laboratory.

The laboratory is the most important part of a course in that it provides a place to investigate, thus optimizing the learning experience. The purpose of this presentation is to discuss an investigative method of teaching plant physiology laboratories as an alternative to the traditional method. This approach provides the student with a greater involvement in the laboratory and, therefore, not only increasing the student's concept of the principles of plant physiology, but also allows for a better understanding of the techniques and methodology of research. This presentation will discuss the organization of the laboratory along with the experiments that are used.

107

VARNEY, DAN R.,[1] JUDITH CUNNINGHAM[1] and JUANITA COX.[2] Eastern Kentucky University[1] and Madison County Schools[2]- - Using Readability Scales in Evaluating Science Texts.

Readability scales used included Dale-Chall, Fog, Flesch, Fry, Smog and Ragor. The study included cloze analyses and a check-list of text organization, visual aids and inclusions. An overall average of all readability scales used show the reading levels of these books to range from 11th grade to college junior, with Turk and Luoma representing these extremes, respectively. Some of the scales, however, will be shown to be inapplicable for the evaluations of college texts. Recommendations will be given for the available scales and measurements to be used in selecting introductory-level texts for general education science courses.

Five texts used in introductory freshman level biology courses for non-biology majors were used in this study. The texts were those used in general education courses at Eastern Kentucky University during the 1984-85 and 1985-86 academic years. The texts evaluated were the most recent editions of the following: C. Starr and R. Taggart, Biology: The Unity and Diversity of Life; S. Luoma, Introduction to Environmental Issues; G. Miller, Living in the Environment; S. Mader, Evolution: Diversity and the Environment; and J. Turk, Introduction to Environmental Studies.

108

BECKMANN, ROBERT L. North Carolina State University--Flavonoids of the white ash (Fraxinus americana L.) polyploid complex.

White ash (Fraxinus americana) is a polyploid complex comprising 2X, 4X, and 6X individuals (X = 23). Natural stands of this species include members of all ploidy levels. Earlier taxonomic treatments suggested that hybridization between this species and green ash has occurred. The flavonoid constituents of each species were identified as potential characters for taxonomic consideration. Comparison of the flavonoid profiles of green ash and of the respective ploidy levels of white ash is complicated by the variability in the latter. The incidence of shared compounds does suggest, however, that interspecific hybridization has occurred.

109

MOORE, MICHAEL O. University of Georgia--A systematic study of selected Vitis taxa in the southeastern United States.

The systematics of North American Vitis is presently in a state of taxonomic confusion. All previous attempts at applying modern systematic techniques have failed to resolve these problems. The purpose of this study was to determine if the flavonoid complements of five closely related southeastern Vitis taxa could be of use in taxon delimitation. Additionally, principal components analysis was employed in an effort to determine which morphological characters were most reliable for species characterization. The taxa chosen for study were V. aestivalis Michx., V. cinerea var. cinerea Engelm. ex Millardet, V. cinerea var. floridana Munson, V. riparia Michx. and V. vulpina L. The flavonoid results indicate that three distinct chemical groups exist: one producing only flavonols (V. riparia, V. vulpina), one producing flavonols and flavones (V. cinerea var. floridana), and one producing flavonols, flavones and C-glycosylflavones (V. cinerea var. cinerea, V. aestivalis). Both the flavonoid chemistry and principal components results were most useful in delimiting the taxa. The principal components analyses showed the morphological characters which were most consistent in circumscription of the taxa.

110

Johnson, Robert and James W. Wallace Jr. Western Carolina University, Cullowhee, NC--The Flavonoid Profile of Cymophyllus fraseri (Andrews) Mackenzie (Cyperaceae).

Initial investigations into the flavonoid profile of Cymophyllus fraseri revealed a high degree of chemical diversity. Thirteen compounds were detected, 8 of which occur in relatively high concentrations. Analysis is currently underway to identify all of the components using ultraviolet spectroscopy as well as column, paper, thin-layer, gas-liquid and high-performance liquid chromatographic techniques. Initial results indicate the presence of several C-glycosylflavones and flavone-O-glycosides as well as their O-Me derivatives. The chemical profile of C. fraseri will be compared with the flavonoid literature of other members of the Cyperaceae, especially Carex with which C. fraseri was allied, and Bisboeckelera, the South American genus considered its closest morphological relative.

111

KEMP, ANDREW C. and WILLIAM H. MURDY. Emory University--An electrophoretic study of the GOT enzyme system in Talinum mengesii.

We studied the glutamate-oxaloacetate (GOT) enzyme system in Talinum mengesii Wolf (Portulacaceae) and by varying constituents of the gel electrophoretic procedure, revealed previously hidden GOT isozyme bands. We found that GOT isozymes are active in at least three subcellular compartments, including the cytosol and chloroplasts. Results from these experiments and from genetic crosses provide evidence for a three-gene model to explain the observed GOT polymorphism in this species. The evidence does not support our original hypothesis of duplicate GOT gene silencing. Results from this study can be instructive for other systematists using electrophoretic techniques.

112

DAY, FRANK P. Old Dominion University--Effects of flooding and nutrient enrichment on biomass allocation in red maple seedlings.

Red maple seedlings were transplanted from the Dismal Swamp to the greenhouse into pots containing organic soil from the swamp. Twelve treatment groups were subjected to combinations of no flooding (NF), continous flooding (CF), and intermittant flooding (IF) and no enrichment, N enrichment, P enrichment, and N+P enrichment. Generally, there was greater shoot and root mass production in the NF seedlings, followed in order by IF and CF. In most cases mass production increased with nutrient enrichment, with the greatest increases occurring in the N+P treatments. There appeared to be little effect of enrichment on total root production in the flooded treatments; however, in the CF seedlings mass of adventitious roots ("water roots") increased and responded to nutrient enrichment while in-soil root mass decreased. There appeared to be no enrichment effects on root/shoot ratios, which decreased from 1.87 to about 0.50 in 4 months. After the first 2 months, the NF seedlings had higher root/shoot ratios than IF and CF seedlings, but those differences were reduced after 4 months.

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KEEVER, CATHERINE[1] and REBECCA SHARITZ[2] Millersville University of Pensylvannia[1] and Savannah River Ecology Laboratory[2] --Effects of geographic location on growth forms of *Heterotheca latifolia* Buckl. and *Heterotheca subaxillaris* (Lam.) Britt. & Rusby.

Plants established from seeds of *H. latifolia* from Mecklenburg County, N.C. and seeds of *H. subaxillaris* from Aiken County, S.C., were grown in both places for comparison of growth forms. Half of the plants were treated with 10-10-10 fertilizer to examine effects of added minerals. In N.C., *H. subaxillaris* plants without added fertilizer were significantly heavier (1291 g dry wt.) than those of *H. latifolia* in the same treatment (409 g); however, fertilized plants of the two species did not differ significantly. Branching patterns appeared dissimiliar between species. In *H. subaxillaris*, all primary stems arose at ground level. Many of these stems lay parallel to the ground for short distances and then curved upward, forming a tumbleweed shaped plant. Half of the *H. latifolia* plants had a central stem along with a few primary branches also arising from ground level. Most of the side branches were straighter and more upright than those of *H. subaxillaris*, and branching of primary stems began higher above ground. In S.C., mortality of both species during a summer drought was high. Surviving plants were small with few branches, and there was no significant difference between species in size of mature plants. Several *H. latifolia* plants failed to bolt and remained in a rosette stage.

114

ROBERTSON, PHILIP A. Southern Illinois University--Tree growth on a lowland site, Union County, Illinois.

A study is in progress on a bottomland site in southern Illinois to assess the effects of watertable dynamics and other environmental factors on tree growth. Growth increment was measured, using a microdendrometer, at 2 points on 116 trees in a *Quercus pagodaefolia* - *Q. Shumardii* - *Carya* spp. stand during the 1985 growing season. More than 50% of the variation in tree growth could be explained by variation in watertable depth, soil moisture and average temperature. Throughout the growing season, watertable depth varied from 0 to > 300 cm. In the past, tree growth on the site, as determined from measuring increment cores, is not related to changes in water level in old river channels surrounding the stand but is related to climatic and disturbance factors.

115

HORN, CHARLES N. University of Alabama--Adaptation to the aquatic environment by species of *Heteranthera*.

Eight taxa of *Heteranthera* were grown at two water depths (3 cm and 15 cm) to investigate differences in development. Six of the eight species produce only 5-15 submersed sessile leaves and subsequently develop floating or emersed petiolate leaves. The other two species produce many sessile leaves and show differential means of developing such that sessile leaves are at or above the water surface. Among petiolate leaf producing species, leaf length and width increase on subsequent leaves, showing no significant difference between water depths. Initial leaves have a L/W ratio of 3-5 and subsequent leaves have a lower ratio. Petiole length shows a dramatic difference between water depths. Initially produced petiolate leaves were as long as or longer than the water depth. Subsequent leaves in 15 cm water had shorter petioles as vegetative stems elongated and in most cases no significant difference was present between plants in 3 and 15 cm of water for the 10th leaf. The above data may be summarized as an aquatic adaptation index, which is based on 1) the number of submersed sessile leaves produced, 2) the presence of petiolate leaves, 3) the elongation of the vegetative stem, and 4) the production of floating and emersed leaves (sessile or petiolate).

116

Ware, Stewart. College of William and Mary--Substrate Adaptation in Rock Outcrop Plants of the Ozarks.

In the Ozarks and Ouachitas glade vegetation has developed on outcrops of dolomite, limestone, sandstone, shale, chert, and igneous rocks. Characteristic herbaceous species vary in presence and abundance according to the substrate. Growth and flowering were used to evaluate success of newly germinated seedlings of glade species on their native and alien substrates under greenhouse conditions. Species of *Sedum*, *Talinum*, *Arenaria*, *Leavenworthia*, *Sporobolus*, *Cyperus*, *Satureja*, *Coreopsis* and *Oxalis* were studied, and *Isanthus*, *Heliotropium*, *Crotonopsis*, *Palafoxia*, *Portulaca* and *Hypericum* are being studied. A number of species grew poorly on alien substrates, but some were essentially substrate-indifferent under greenhouse conditions, and it was not unusual for species to grow better on alien than on native substrate. Sedum pulchellum populations grew best on limestone regardless of substrate of origin; Arenaria patula populations showed pronounced ecotypic differentiation on different substrates. No generalized pattern is detectable even among species all growing together on the same substrate; each species seems to respond to substrate types based on its individual ecological/evolutionary history.

117

MADDOCK, MICHAEL B. and FRANK J. SCHWARTZ. Institute of Marine Sciences, University of North Carolina--Cytotaxonomic studies of the elsamobranchs.

The living sharks, skates, rays and chimaeras, which represent one of the earliest branches of gnathostome vertebrate evolution, have recieved little attention in speculative attempts to reconstruct the phylogeny of the vertebrate genome primarily because of the lack of reliable cytogenetic data for these species compared to that available for other vertebrate groups. Conventional cytogenetic procedures that are used to karyotype teleost fish cannot be used with species which are large or difficult to maintain in captivity and are only marginally successful for the smaller and more easily maintained elasmobranchs. We have recently developed methods based on blood cell culture that are not subject to these limitations and which have been used to obtain karyotypes for 25 species, including some of the larger shark species. The data from these studies combined with data from others that are considered to be reliable suggest the following ranges for the values of various cytogenetic parameters: fundamental numbers range from 56 to 136 chromosome arms per diploid cell; chromosome numbers range from 28 to 104 chromosomes per diploid cell; the percentage of the diploid chromosome complement that are telocentric range from 0 to 100; cellular DNA contents, measured by flow cytometry in our studies, range from 6.6 to 19.6 pg per diploid (G0) cell. Analysis of phylogenetic trends in these parameters suggest a number of hypotheses concerning the structure of the ancestral elsamobranch genome and the subsequent elaboration of the genetic systems of the major elasmobranch groups.

118

SCHMID, THOMAS H. AND F.F. SNELSON, JR. University of Central Florida--Spine growth and regeneration in the Atlantic stingray.

Spine growth and regeneration were studied in 15 Dasyatis sabina housed at Sea World in Orlando, Florida as part of an age and growth study. Animals were divided into three groups according to spine treatment. In group one spines were broken off at their base. In group two the spines were surgically excised. In group three spines were left intact. Measurements and notes on condition and number of spines were made at biweekly intervals. New spine growth (regeneration) took place within one month in 60% of rays in group one and three, and 50% of rays in group two. 100% regeneration in all groups was noted by the third month. The data seems to indicate initial rapid growth followed by slowed growth as maximum size is reached. Quarterly samples are being taken to determine any seasonal patterns in growth and regeneration. Identical experiments will be carried out on field housed rays and tagged and released rays.

119

GOBALET, KENNETH W. Loyola University New Orleans--Analysis of fish remains from archaeological site CA-Mnt-229, Elkhorn Slough, Monterey County, Calif. indicates major recent habitat disruption.

Fish materials analysed from archaeological site CA-Mnt-229 are from both fresh and salt water fishes. The Sacramento perch, Archoplites interruptus, is found in the most units and levels of the species identified here. It and the tuleperch, Hysterocarpus traskii (also identified here) are extinct from the Pajaro and Salinas Rivers. Remains of the thicktailed chub, Gila crassicauda, document a range extension into the Pajaro-Salinas drainage basin for this extinct species. The extinction of three freshwater fishes indicates major habitat disruption of these streams during recent times. Remains of seven species of freshwater, at least sixteen species of marine and five species that might be found in either habitat were also identified. Analysis of the growth rings of vertebrae indicate the probable year-round occupation of this site by Native Americans. Fishing was probably exclusively local at a time when the Salinas (and/or Pajaro River) entered the Monterey Bay through what is now Elkhorn Slough.

120

MENHINICK, EDWARD F. University of North Carolina at Charlotte--Production of fish illustrations.

A method of making accurate illustrations of fishes, with minimal effort is described. Preserved fishes were pinned so that bodies and fins would be in desired positions and were photographed with Recordak positive film. The resulting slides were projected onto the underside of a tracing table containing clear glass, and a tracing was made. After refining the tracing by examination of the fish, an ink line drawing was made, a copy of which was then shaded with charcoal and pencil to show natural shading of the fish. A half tone drop out negative reduced to 32% was made of the drawing for publication.

121

BASSIN, DENNIS M. University of South Carolina--*Constraints and Considerations in Teaching Field Biology to Orthopedically Handicapped College Students*. Handicapped students have typically restricted their post-secondary studies to the humanities and social sciences. This is partially due to the low utilization of existing natural areas which have been modified to provide a least-restrictive environment. Greater utilization of these areas would enable handicapped natural science students to function as fully contributing group members in the field. While realistic limitations will be delineated, several creative alternatives for planning of field activities will be illustrated and explained.

122

BAUMAN, THOMAS R., JOLANTA M. WILMAN and EARLE A. CROSS University of Alabama--*Observations on eclosion of the mud-dauber wasp, Trypoxylon politum*. Some morphological and physiological events preceeding eclosion in the commom mud-dauber wasp have been investigated. The pigmentation and tanning of the lateral aspect of the anterior abdominal segments can be used to predict the time of eclosion. Wasps reared at 18°C ct develop fully within the cocoon, but fail to eclose. Wasps reared at 22°C ct and higher do eclose. Wasps reared in a L/D regime of a summer day tend to eclose more often in the L phase than in the D phase. Wasps reared in total darkness appear to eclose at random. The central nervous system is composed of a brain, subesophageal-compound thoracic-and three abdominal ganglia. The collective nervous system as well as its component parts have been assayed in the larval hornworm system and in pre-eclosed wasps for an "eclosion" type factor or hormone. Preliminary results do not indicate the presence of such a factor. The study was funded by Research Grants Committee, University of Alabama, project # 1209.

123

BONNER, META. North Carolina State University--*Puberty onset in golden hamsters prenatally exposed to phenobarbital*. Barbiturates are suspected of altering developing reproductive functions, sometimes expressed as alterations in sexual maturation. This project investigated if prenatal exposure to phenobarbital could affect puberty onset in hamsters. Female hamsters were injected s.c. on day 9 through day 14 of gestation with 40mg/kg body weight of sodium phenobarbital. Controls received 0.9% saline solution. Puberty onset in female offsprings was determined by the Orsini's method (1961). Puberty onset in male offsprings was determined by penile smear using the Vandenbergh's method (1971). The results showed a significant later puberty onset for the phenobarbital groups. In females the phenobarbital treated group had a mean of 33.69±.60 vs. 29.87±.92 for controls ($t=-3.53, p<.005$, 19 litters). For males the mean for phenobarbital treated group was 40.26±.26 vs. 39.41±.36 for controls ($t=-1.855$, $p<.05$, 19 litters). Prenatal exposure to phenobarbital significantly alters timing of sexual maturation in golden hamster, with an apparent stronger influence in females than in males.

124

DINDO, JOHN J. and KEN R. MARION. Dauphin Island Sea Lab, and University of Alabama at Birmingham--*Initial observations on an Alabama coastal heronry*. Studies of factors controlling nesting success on a coastal heronry in Alabama were begun in 1984 on Cat Island (5.2 ha.). This island has an unusually high shell hash perimeter and a dense stand of marsh elder (*Iva frutescens* and groundsel tree (*Baccharis halimifolia*), supporting a mixed-species nesting colony of approximately three thousand herons and egrets. Tricolor Herons (*Hydranassa tricolor*) and Snowy Egrets (*Egretta thula*) were the first to establish nests at the end of March, followed by Little Blue Herons (*Florida caerula*), Reddish Egrets (*Dichromanassa rufescens*), American Egrets (*Casmerodius albus*) and Cattle Egrets (*Bubulcus ibis*). No major storm events significantly affected nesting success during 1985. Nesting success for Tricolor Herons (79.8%) and Cattle Egrets (59.7%) in the current study did not significantly differ from a 1977 study (Tricolor = 71.1%; Cattle = 58.4%). The majority of hatchling deaths occurred in the nest and were not due to predation. Cattle Egrets nested later than other species and by mid-July comprised 75% of the colony. Most young birds had fledged by August 1985 when Hurricane Elena hit. The effects of the storm on vegetation used for nesting were substantial and the impacts on colony structure and success will be monitored during 1986.

125

MCCORMICK, J. FRANK. University of Tennessee - *International Training in Natural Resource Management*.

Individuals with resource management responsibilities in developing nations have participated in a University of Tennessee international training course in applied ecology each summer since 1980. The course is supported by the Agency for International Development (AID), Food and Agriculture Organization (FAO), the United Nations Environmental Program (UNEP) and the U.S. Department of Agriculture. The main focus is upon demonstration of best ecological science and technology available for resource management. Five MAB Biosphere Reserves are among numerous research sites visited. Other activities include presentations of case studies by participants and a review of ecological concepts and methods most applicable to natural resource management. Lectures most relevant to participant needs typically include remote sensing, tropical forestry, protection of endangered species, agroecosystems resource economics, environmental assessment, land use planning, short rotation woody crops and soil conservation. Activities are selected, in large part, on the basis of their relevance to integrated resource management. Course activities demonstrate that all natural resources are interconnected and interrelated components of ecological systems. Because management systems should be compatible with the systems being managed, intergrated resource management is proposed as the most compatible and effective management strategy. Research methods, appropriate technologies, planning methods, and management strategies are reviewed and evaluated for inclusion in intergrated resource management programs in developing nations.

126

ROHDE, FRED C. and RUDOLF G. ARNDT. North Carolina Division of Marine Fisheries, and Stockton State College--Two new Elassoma from the Carolinas.

The genus Elassoma consists of at least six species, four of which occur in North and South Carolina. Elassoma zonatum is the most common and is widely distributed throughout the Coastal Plain of both states. Elassoma evergladei is less common and is found only in southeastern North Carolina and in scattered locations throughout coastal South Carolina. The two new species are at present known only from nine localities in five drainages. New species A occurs in both states while new species B is currently known only from southernmost South Carolina. Both new species resemble E. evergladei in body shape but have vertical body bars similar to E. zonatum. They lack the shoulder blotch of E. zonatum. Species A and B differ from each other in number and width of the vertical bars and in several morphological measurements.

127

STEPHENSON, STEVEN L. Fairmont State College--Distribution and ecology of Myxomycetes in southern Appalachian spruce-fir forests.

A study of the distribution and ecology of Myxomycetes (plasmodial slime molds) in southern Appalachian spruce-fir forests was carried out during the period of 1982-85. Field and moist chamber collections were made from three different study areas: (1) Blister Run in Randolph County, West Virginia; (2) Mount Rogers in Grayson County, Virginia; and (3) the Great Smoky Mountains National Park in North Carolina. Sixty-two species representing 27 genera have been identified to date. This total includes a significant number of species that seem to display a distinct preference for coniferous substrates and/or appear to have distributions centered in montane regions. Prominent examples include Barbeyella minutissima, Colloderma oculatum, Cribraria ferruginea, Cribraria purpurea, Cribraria rufa, Dianema corticatum, Diderma roanense, Lamproderma columbinum, Lepidoderma tigrinum, and Trichia erecta. As such, the Myxomycetes associated with southern Appalachian spruce-fir forests constitute a rather distinctive ecological group which includes a number of species that are rarely encountered in forests at lower elevations in the region. It is interesting to note that several of the species encountered in this study would seem to be bryophilous, inasmuch as they are almost always found in association with bryophytes, particularly leafy hepatics.

128

WHITE, DAVID A. Loyola University of New Orleans, Louisiana--Sedimentation and plant colonization on two inner deltaic splays within the lower Mississippi River delta.

Louisiana is losing coastal marshlands at an ever increasing rate due to subsidence since silt-ladden waters of the State's coastal rivers and streams are no longer permitted to flood the marshland and thus accrete it. Over the years levees have been constructed and maintained to force waters past the marshes to the Gulf of Mexico. Because Louisiana's 1.7 million hectares of marshes and associated water bodies are the mainstay for the fishing and hunting industry concern has grown over the subsidence rate. The Mississippi River is certainly foremost in rivers that could slow subsidence by again supplying silt to the marsh. This study investigated sedimentation rates and plant colonization on two inner Mississippi River delta splays that are forming as a result of changes in levee maintenance practices brought by the concern. Yearly sedimentation rates exceeded 10 cm and resulted in an eight fold increase in site size due to accretion (from 4300m^2 to 36,700m^2). Colonization by plants was rapid and by the end of the first summer ten species (the dominants including Cyperus erythrorhizos, Leptochloa panicoides, Sphenoclea zeylanica, Fimbristylus vahlii, Cyperus difformis, Salix nigra and Sagittaria graminea) accounted for 90% of the 980 g/m2 biomass. Of all the species present only Salix nigra is woody and therefore is predicted to be the most dominant species the second year.

129

WHITE, DAVID A. and MICHAEL J. SIMMONS. Loyola University of New Orleans, Louisiana --Phenology and primary productivity within the marshes of the lower Pearl River basin, Louisiana.

The Pearl River is one of the major Gulf coastal streams and it forms the southeastern boundary between Mississippi and Louisiana. About 10 km before reaching the Gulf of Mexico its waters have spread through a freshwater marsh in a network of channels within a basin of about 5 km width. These fresh waters encounter the saline Gulf waters to form a large estuarine complex. This study monitored the primary productivity of individual species at three distinct sites located along the basin's salinity gradient. Growth and peak flowering periods were determined for the nearly twenty commonly encountered species. Of these species about ten (Spartina patens, Sagittaria lancifolia, Phyla nodiflora, Peltandra sagittaefolia, Vigna luteola, Saururus cernuus, Polygonum punctatum, Polygonum sagittatum, Panicum spp. and Eleocharis spp.) accounted for over 98% of the basin's marsh productivity. Using the Smalley method net primary productivity was 1240 g/m^2/yr for the freshwater marsh; 1745 g/m^2/yr for the intermediate marsh; and 2260 g/m^2/yr for the brackish marsh. Some of the disparity in the estimates of marsh production resulted from the method used. No estimate of loss by decomposition or grazing is incorporated in these estimates and this loss is probably most significant in the fresh marsh and then in the intermediate marsh.

130

PINDER, J. E., III, AND T. A. CHRISTIANSEN. Savannah River Ecology Laboratory--The effects of residual fertilizers on the productivity of plant communities in secondary succession.

Studies of old-field succession on the Savannah River Plant in the early 1950's suggested that residual fertilizers from agricultural operations increased the net productivity of successional plant communities. However, subsequent studies failed to support the earlier results. The conflict among these studies was investigated by examining successional processes on fertilized and unfertilized sections of an abandoned corn field. Net productivities on fertilized and unfertilized sections were compared over a five-year period, and nutrient addition experiments were performed to identify limiting nutrients. The data indicate 1) that residual fertilizers do increase net productivity and 2) that conflicting results from previous studies were caused by differences in methods.

131

MEGONIGAL, J. PATRICK and FRANK P. DAY. Old Dominion University --Models of organic matter dynamics in the Great Dismal Swamp, Virginia.

Models of organic matter dynamis were developed for one mesic and three seasonally flooded plant communities in the Great Dismal Swamp, Virginia. Component classes include aboveground parts, belowground parts, litter and soil organic matter. Projected standing stocks compared well with data from the literature. Simulations suggest the study sites, which are approximately 100 years in age, will reach quasi-equlibrium in about 150 years. The most dramatic changes were on the cedar site which became dominated by maple and gum species. Other sites remained compositionally the same. Aboveground biomass on the cedar site decreased and became quite similar to the maple-gum and mixed hardwood sites (~24,000 g m^{-2}). The cypress site maintained the highest aboveground biomass (~40,000 g m^{-2}). Accumulation of soil organic matter (SOM) on the cedar site decreased from 61,200 g m^{-2} to 27,871 g m^{-2}. SOM on the cypress site increased to 24,301 g m^{-2} while accumulation on the maple-gum site remained fairly constant at 22,175 g m^{-2}. Results suggest the Dismal Swamp may be a more homogeneous ecosystem by the next century. Predictions will be discussed in the context of model sensitivity and error associated with parameter quantification.

132

WEST, SUSAN K. and FRANK P. DAY. Old Dominion University--Estimates of fine root biomass in four communities within the Great Dismal Swamp.

Fine root biomass is currently being studied in four plant communities within the Great Dismal Swamp, Virginia. Ten soil cores to a depth of 40-cm are being extracted monthly from each of the four communities. Roots are removed from soil cores via washing through sieves and are classified as live or dead. Roots are then dried and weighed. Preliminary results based on April samples indicate a significantly greater ($P<.024$) amount of live roots within the mixed hardwood community than within the cypress or maple-gum communities. Amount of dead roots is lowest within the cypress community. Total amount of fine roots is highest in the mixed hardwood followed by the cedar and maple-gum communities respectively. The cypress community, the most extensively flooded, has the least amount of roots.

133

TUPACZ, EDWARD G. and FRANK P. DAY Jr. Old Dominion University--Root decomposition in the seasonally flooded Great Dismal Swamp.

Root decomposition on four selected sites in the Great Dismal Swamp is presently being quantified by two methods. One method involves a modified litter bag technique and a second involves sampling by cores. On each of the four sites 130 pipes were put out initially, with a set of 10 taken for initial characterization. Samples of 10 are being taken bimonthly and decay is based on mass loss. All samples are analyzed in 10 cm increments to a depth of 40 cm. and core samples are sorted into three size categories: <2 mm, 2 - 5 mm, and >5 mm in diameter. Preliminary analysis after 36 weeks indicates no significant difference in decay between the four depths on the Atlantic White Cedar, mixed hardwood, and maple - gum sites. The cypress site had a significantly higher percent weight remaining in the 30 cm (p=.031) and 40 cm (p=.022) sections from the 10 cm section. The cedar site appears to exhibit the slowest root decay rates.

134

HARKER, ANNE C., CORY W. BERISH, and HARVEY L. RAGSDALE. Emory University--The role of black locust (Robinia pseudoacacia) in root dynamics of regenerating southern Appalachian forests.

Black locust is an early successional, nitrogen-fixing species which can increase above- and below-ground community biomass, primarily through increasing ecosystem nitrogen. To quantify the role of black locust in below-ground ecosytem development, coarse (~25mm diameter) and fine (< 3mm diameter) roots were examined in two, 18 yr-old forests, one dominated by black locust, the other a mixture of pine and hardwoods. Three hundred coarse root and 500 fine root decomposition bags were placed in the A1 soil horizon of the two stands. Tulip poplar, black locust, and Rubus coarse roots lost 25% of their original dry mass after one year in the black locust stand. Conversely, in the mixed hardwood stand, dry mass loss was smaller: losses ranged from 1-2% for Kalmia to only 15% for pine. Fine root decomposition rates were very similar in both forest stands. Tulip poplar, black locust, and Rubus exhibited 50, 20, and 70% loss respectively in the black locust stand. Tulip poplar, Kalmia, and pine showed 50, 25, and 45% loss in the mixed hardwood stand. Fine root decomposition rates do not appear to be affected by soil nitrogen availability, while higher soil nitrogen availability in the black locust stand may increase coarse root decomposition rates.

135

SCHMALZER, PAUL A. and C. ROSS HINKLE. The Bionetics Corporation and NASA, KSC Biomedical Office, John F. Kennedy Space Center--Biomass, nutrient concentrations and nutrient standing crops in different age stands of oak scrub vegetation on John F. Kennedy Space Center, Florida.

Oak scrub vegetation dominated by shrub oaks, ericads and saw palmetto occurs on well-drained, nutrient-poor, sandy soils on Merritt Island, Florida. Four stands, 2, 4, 8, and 25 years post-fire were sampled; biomass was harvested on $1m^2$ plots, and soils were collected from the 0-15 cm and 15-30 cm layers. Plant tissue samples were analyzed for TKN, P, Ca, Mg, K, and Al. Live biomass increased with time from fire, litter biomass increased for about 8 years post-fire, but standing dead biomass did not change significantly with time. Tissue nutrient concentrations did not change consistently with time since fire. Standing crops of nutrients responded to changes in biomass. Saw palmetto rhizomes and standing dead biomass formed major pools of biomass and nutrients which may be important in nutrient conservation after fire. Nutrient concentrations and pools were similar to those in chaparral and other shrub-dominated ecosystems.

136

Potter, Christopher S., and Harvey L. Ragsdale. Emory University--Acid deposition interactions with a southern Appalachian forest canopy at the Coweeta Hydrologic Laboratory.

This study is located within a regenerating hardwood forest, WS 7, which was clearcut by cable-logging in 1977-78. The present forest canopy extends to 10 meters height and the LAI of 5 to 6 is similar to that of the original forest. Precipitation chemistry changes resulting from interactions with leaf surfaces are being analyzed on a storm event basis. Comparisons of storms collected during the dormant and growing seasons reveal that the changes in precipitation are primarily quantitative in nature. Qualitative chemistry patterns remained fairly constant, showing a net canopy absorption of H+ and NH_4^+ and net enrichment of K+, Ca++, Mg++, Na^+, SO_4^{--}, NO_3^-, PO_4^{---}, and Cl^- in throughfall. Quantitative trends in net throughfall chemistry appear to be closely related to the time of the season and the length of the dry period before each storm event.

137

WINSTEAD, Joe E. and John T. Riley. Western Kentucky University--Latitudinal variation of sulfur in wood of Carpinus caroliniana and relationship to anthropogenic sulfur deposition.

Secondary wood tissues formed in trees of Carpinus caroliniana Walt. (Ironwood) during the growing seasons of 1970-72 showed sulfur accumulations in excess of 1% from populations in the states of Michigan and Indiana at locations north and east of major industrial centers of Illinois. Populations of this species from southern Indiana extending to the coastal plain of Alabama had sulfur levels of .5% in wood formed during the same time span as the more northern populations. The lower levels of sulfur from the field collected samples originating from below 38 degrees North Latitude appear to match the known lower levels of industrial deposition of sulfur during the 1960's and 1970's.

138

WARD, DEANNA, PETER NIELSEN, and DEAN COCKING. James Madison University, Harrisonburg, VA--Bioaccumulation of mercury in flood plain forest trees along the South River at Waynesboro, VA.

Mercury contamination in bottom sediments and adjacent flood plain soils of the South River occurred prior to 1950. In 1980, the Virginia State Water Control Board estimated that 37,000 kg of mercury were deposited on 250 ha of the flood plain with an average concentration of 34.5 ppm. This study surveys the extent of mercury accumulation in *Acer negundo*, *A. saccharinum*, *A. saccharum*, *Juglans nigra*, *Platanus occidentalis*, and *Prunus serotina* collected from flood plain forests 3.0-3.5 river miles upstream and downstream from Waynesboro, VA, the point source origin of the mercury. Root, bark, wood, and leaf tissues were collected from a mercury contaminated site with a mean concentration of 22.0 ppm in the soil and compared with samples collected from a site with a soil concentration less than 0.2 ppm. In the laboratory the samples were washed, rinsed with dilute nitric acid, air dried, passed through a No. 40 mesh Wiley mill sieve, and wet digested with concentrated nitric and sulfuric acid. Total mercury concentrations were determined using a mercury hydride system with a Perkin-Elmer 3030 atomic absorption spectrophotometer. Highly significant differences in total mercury concentration were observed between most samples from the contaminated site in comparison with corresponding control tissues. For example, mean mercury concentrations for root and leaf tissues at the high level mercury site ranged between 0.26-2.28 and 0.10-0.45 ppm respectively. Whereas, at the control site, tissue mercury concentrations did not exceed 0.15 ppm.

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LUVALL, JEFFREY C. AND JAMES E. ANDERSON. NASA, National Space Technology Laboratory--Thermal infrared energy processes in western coniferous forest canopies.

Forest canopy temperatures in the H. J. Andrews Experimental Forest in Oregon were determined using an aircraft mounted Thermal Infrared Multispectral Scanner (TIMS). After atmospheric affects are eliminated, actual forest canopy temperatures can be determined to the nearest 0.2°C for a 10 x 10 meter pixel size. Results indicated that daytime canopy temperatures closely followed air temperatures. Generally the older forest stands had the lowest canopy temperatures. At night, radiative energy transfer cooled the higher elevation forest canopies faster than the surrounding air, causing cold air drainage through the lower forest valleys.

140

Woods, F. W. and M. Hughes
Department of Forestry, Wildlife and Fisheries, University of Tennessee.
Wood Density of Three Oak Species in East Tennessee: 1940-45 and 1970-75

Wood density of three species of oaks in forests of East Tennessee were investigated at five locations in the vicinity of two coal-fired power generating facilities operated by the Tennessee Valley Authority. Increment cores were collected and two periods (1940-45 and 1970-75) were analyzed by gamma-densitometry. Annual rings were partitioned by latewood and earlywood and their components of average earlywood, average latewood, minimum earlywood, maximum latewood, and average periodic (1940-45, 1970-75) densities. When all trees of each species on all sites were analyzed, all component densities for white (Quercus alba L.) and chestnut (Quercus prinus L.) oaks were greater for the period of 1940-45 than for 1970-75. Only for the minimum earlywood density of chestnut oak was the level of significance less than P=0.01. For black oak (Quercus velutina L.) differences between the two time periods were found only for mean earlywood (P=0.05), maximum latewood (P=0.05) and mean periodic densities (P=0.01). Mean periodic density was less for 1970-75 (P=0.01) for all three species.

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HEINS, DAVID C. and JOHN A. BAKER. Tulane University and Waterways Experiment Station, U.S. Army Corps of Engineers--Natural history of Percina vigil Hay in the Homochitto River, Mississippi.

Almost no published data are available on the life history of *Percina vigil*. Herein we describe the natural history of this little known species, based on monthly collections taken 1984-85. In 1985 the reproductive season began prior to our mid-March collection. Examinations of ovaries showed that reproduction started earlier in March or possibly very late February. Reproduction continued through mid-April and ended before mid-May. Reproductively mature females had two groups of yolk-bearing oocytes in their ovaries; these and other data show that *P. vigil* produces multiple clutches of eggs. Thus, our fecundity data represent clutch sizes of reproductively mature females which produced 60-317 ova per clutch (n=23). Mature, unovulated eggs in 20 females were 0.65-0.92 mm diameter and averaged 0.78 mm diameter.

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PIERSON, J. MALCOLM. Alabama Power Company, Department of Environmental Affairs--Distribution and status of rare fishes in the lower Cahaba River, Alabama.

The Cahaba River is located within the Mobile River basin and is a major tributary of the Alabama River in central Alabama.

Eighty-three collections have been made in the lower Cahaba drainage with seine, gill nets, and electrofishing equipment from May 1981 to October 1985. Over 32,000 specimens have been collected comprising 20 families and 103 species. Distribution records are presented for five rare or environmentally sensitive fishes that occupy the main channel Cahaba River or a few of its larger tributaries. Range extensions were discovered for *Notropis* sp. cf. *volucellus* (undescribed Cahaba shiner) and *Percina aurolineata* (goldline darter). Distribution records from the Cahaba are also presented for *Noturus munitus* (frecklebelly madtom), *Ammocrypta asprella* (crystal darter) and *Percina lenticula* (freckled darter). *Notropis candidus* (silverside shiner) is reported from the Cahaba River for the first time. Thirteen other species usually associated with large river habitats are documented from the lower Cahaba. The Tombigbee and Alabama rivers have undergone various degrees of environmental stress due to impoundment and dredging. Populations of these species have been severely reduced or eliminated in these systems. It appears that the Cahaba River is serving as a refugium for many vulnerable riverine species.

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ROHDE, FRED C. and STEVE W. ROSS. North Carolina Division of Marine Fisheries, and North Carolina State University--*Life history of the swampfish, Chologaster cornuta, with comments on morphological changes*.

Aspects of the biology and morphology of a population of *Chologaster cornuta* in eastern North Carolina were examined in 1977-78. Reproduction occurs from early March to mid-April at a water temperature from 13 to 19 C. Mature ova number ranges from 10-98 (mean = 26.6). Mean ovum diameter is 1.48 mm. Maximum life span is two years. Sexual maturity is attained at one year. Females are longer than males (48 mm SL vs 41 mm). Sex ratio is 1.69 females:1 male. Commonly occurring foods were amphipods (in 58.8% of stomachs), cladocerans, and chironomids. Diet is constant throughout life. The vent migrates anteriorly with growth of the fish. Males develop a structure on the upper jaw which is apparently associated with reproductive behavior.

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PETERSON, MARK S. University of Southern Mississippi--*Use of peripheral oligohaline marshes by centrarchids: intrafamilial properties of osmotic adaptation*.

Oligohaline marshes are typically interface habitats between freshwater source rivers and their salt marsh terminus. These habitats have been documented as low diversity systems due to fluctuating abiotic conditions; however, numerous freshwater and marine fish species use these systems during all or part of their life history. In particular, the centrarchids have been shown to be, at least seasonally, the major ichthyopredators. Moreover, freshwater fishes in general are near their upper osmoregulatory limit when in low salinity habitats. Due to their sport fishery value and their osmoregulatory constraints, centrarchids are ideal for examining underlying osmoregulatory mechanisms of freshwater fish penetration into oligohaline marshes. This study concerns the intrafamilial properties of osmotic adaptation among three centrarchids. In general, it documents little difference in 48 hr time course and hematocrit values. Moreover, the typical "U-shaped" salinity response curve is not indicated for the three species. However, it does suggest that 1) spotted sunfish, *Lepomis punctatus* maintains a slightly greater internal osmolality in salinities of 0, 2, 4, 6 and 8 ppt, than the redear, *L. microlophus* and the spotted bass, *Micropterus punctulatus*; and 2) that all species are good hyper-regulators up to their isosmotic point. Variation in osmolality values among individuals within and across mean salinity treatment data suggest that the osmoregulatory properties synergistically coupled with recent acclimitization histories (relative position along the salt gradient) provide evidence for the relative abundance and penetration of centrarchids into peripheral oligohaline marshes.

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SECOR, DAVID H., JOHN MARK DEAN, AND P. W. HAAKE. Department of Biology and Belle W. Baruch Institute for Coastal Research and Marine Biology, University of South Carolina, Columbia, South Carolina--*Somatic-otolith growth comparisons in larval and juvenile striped bass and spot*.

Otoliths are calcium concretions in the inner ear of fishes. Within the microstructure of otoliths, a lamellar pattern of growth increments is observed. These increments form with a daily frequency in many species. Recent reports indicate a relationship between width of growth increments and daily somatic growth rate. We investigated otolith and somatic growth in larval and juvenile striped bass (*Morone saxatilis*) and spot (*Leiostomus xanthurus*) from impounded and wild habitats. Regression analysis showed that otolith size was highly correlated to fish length. However within each species, the allometric regressions had higher slopes in slower growing groups of fish. Therefore the relationship between otolith and fish size is not nessesarily species or population specific. Based on our results, we suggest two components of otolith growth: 1. Otoliths grow by daily accretion of calcium carbonate crystals. This process is apparently defined by an endogenous rhythm and hence not directly linked to fish growth. 2. The width of each growth increment is influenced by daily somatic growth. Other studies have shown different allometric relationships within the same species. Our study demonstrates a link between allometric relationship and growth rate. We speculate that otolith-fish size comparisons can be used to index past somatic growth.

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SCHWARTZ, FRANK J. AND BRENT K. CONWAY. Institute of Marine Sciences, University of North Carolina--Age-growth, body-organ weight, and length-weight relationships for the sciaenid, Stellifer lanceolatus, from estuarine Cape Fear River, North Carolina.

Spawning of the diminutive sciaenid star drum, Stellifer lanceolatus, extends near the estuarine Cape Fear River, North Carolina, from late spring through September. Young of the year occur July through November. Yearlings dominate fall catches. Few live beyond 1 yr or 115 mm standard length (SL). Maximum size is 184 mm SL. Body-organ weight relationships of gut, spleen, pancreas, heart, gonads, kidney, brain, liver, and eyes for age class 0 and 1 males (42-115.9 mm SL) and females (46.9-115 m SL), captured in April and September 1973, 1974, and 1975, exhibited hypermegalistic growth. Pancreas weights were most variable, decreasing with age. Gonad and liver weights varied most seasonally and yearly. Statistically, ANOVA's of body-organ regression slopes (b's) found no month, year or month/year interaction differences. Steepest linear regression slopes were for spleen, pancreas, heart, gonads, and kidney data. Brain, liver, and eye weights were best correlated to body weight, age, and size. Of the nine, three year body-organ weight relationships (27), male regressions were steepest 15/27 times in April vs. 9/27 in September; whereas female slopes were steepest 12/27 times in September vs. 7/27 in April. Standard length-weight relationships (sexes combined) were: Log w = 6.95 log L-10.61 (n=3031) in 1973, Log w = 6.49-9.81 (n=4034) in 1974, and Log w = 6.17 log L-9.16 (n=5139) in 1975.

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MIDDENDORF, GEORGE A. AND BELA J. DEMETER. Howard University and National Zoological Park--Behavioral interactions of the Chinese Water Dragon (Physignathus cocincinus).

The Chinese Water Dragon, a large, arboreal lizard, inhabits the eastern regions of Indo-China and the southern provinces of China. Studies of this species and other members of its genus are few and reports documenting its behavior almost nonexistant. Since other representatives of the Agamidae show diverse, elaborate and unusual behaviors we felt this species worthy of investigation. Five P. cocincinus, members of a group maintained at the National Zoological Park since 1974, were placed in a large exhibit cage. Video recordings were made when other, individually-housed members were introduced for breeding and observation. Analysis of the behavioral sequences show that this species has a large and varied repetoire that includes such behaviors as gular extension, head bobbing, tail lashing, push ups (both two- and four-legged), jaw sparring and circumduction, of which only the first two have been reported. Further, this species appears to utilize chemical communication to a greater degree than previously thought for this family; tongue touches to substrates and to opponent's heads during interactions, especially during jaw sparring, were observed.

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HOWE, JEFFREY C. and DAVID G. LINDQUIST. University of North Carolina at Wilmington--Efficacy of midwater fish aggregating devices (FADs) placed near two piers at Wrightsville Beach, N.C. in attracting coastal fishes.

Midwater fish aggregating devices (FADs) were deployed off of two piers in Wrightsville Beach, N.C. to evaluate their ability to attract coastal fishes. Three structure types, midwater FADs, FAD anchor weights, and surface spar buoys were deployed within the experimental site and observed using SCUBA from May 19-August 26, 1984. The total fish fauna observed at the experimental site included 35 species (21 fam., 31 gen.). Of the 35 species, 27 species (17 fam., 24 gen.), 18 species (14 fam., 18 gen.), and 14 species (7 fam., 12 gen.) were observed at the midwater FADs, FAD anchor weights, and surface spar buoys, respectively. Caranx crysos and Peprilus triacanthus were the most abundant species observed at the FADs. There was an average of 5.48±1.92 species observed at each FAD. Water visibility and temperature averaged 4.6 m and 22.8 C, respectively. There was no significant correlation in the mean number of fishes sighted at the FADs at various visibilities or temperatures. During a 24 hr and 2 week diel study, 10 species (7 fam., 10 gen.) and 14 species (8 fam., 12 gen.) were observed at the FADs, respectively. The abundance of Caranx crysos was significantly greater during the day when compared to night periods. The FADs appeared to be used differently according to each fish species. These uses included orientation, feeding, and predator avoidance.

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STEPHAN, C. DIANNE and DAVID G. LINDQUIST. University of North Carolina at Wilmington--An evaluation of midwater vs. benthic structures as fish aggregators.

A two-model combination of twelve McIntosh fish aggregating devices (FADs) was deployed in four vertical arrays in 18 m of water ten miles offshore of southeastern North Carolina on May 15, 1985. Two "batwing" and one "delta" model FADs were attached to a vertical line at 4, 8, and 12 m below the surface on each of the four arrays. The two FAD models have 6.7 m^2 and 11.6 m^2 of surface area, respectively. Diver censuses of fish aggregations around the FAD arrays commenced on June 1, 1985, and have continued on an irregular basis (weather permitting) through the fall of 1985. The effectiveness of the FAD arrays is contrasted with fish surveys at an adjacent tug wreck (see abstract by Lawrence and Lindquist). A total of thirteen species was observed at the FADs. Of these, all but three FAD species (orange filefish, Aluterus schoepfi; planehead filefish, Monacanthus hispidus; and rainbow runner, Elagatis bipinnulata) were common to both FADs and tug. Nine of the thirteen FAD associated fishes were pelagics. The most abundant species at the FADs was the round scad (Decapterus punctatus) which was later joined by large aggregations of a clupeid species. These two species formed cohesive schools of thousands of individuals that treated the three FAD units as one large unit extending from the surface down to 12 m. Per square meter of surface area, the FADs are at least equal to or greater than the tug in aggregating pelagic baitfish. Sportfishes such as amberjack (Seriola dumerili), Spanish mackerel (Scomberomorus maculatus) and barracuda (Sphyraena barracuda) were also commonly associated with the FADs.

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LAWRENCE, COLLEEN M. and DAVID G. LINDQUIST. University of North Carolina at Wilmington--A comparison of fishes associated with an old and a new ship wreck.

On February 27, 1985, two tugboats were sunk 300 m east and west of an old (>40 years) dredge wreck in order to establish a new artificial reef off southeastern North Carolina. The dredge measures 50 m by 15 m with a relief of 5 m. One tug is 26 m long with a beam of 7 m and relief of 9 m. Both wrecks are in 18 m of water ten miles offshore. A study was initiated on April 27, 1985, to compare the fish communities associated with the one tug and the dredge wreck. Multiple point censuses were taken by divers on each wreck at irregular intervals (weather permitting) through the fall of 1985. A total of 38 fish species was observed during censuses. Twenty-one species were common to both wrecks. Thirteen species occurred only at the dredge while four species were only counted at the tug. Round scad (Decapterus punctatus) was the most abundant species at both wrecks and is likely not to differ in abundance at each wreck (analyses pending). Reef species common to both wrecks were tomtate (Haemulon aurolineatum), spottail pinfish (Diplodus holbrooki) and black sea bass (Centropristis striata). Round scad, tomtate and spottail pinfish rapidly colonized the tug wreck. Analyses not yet performed will likely show a greater abundance of tomtate and spottail pinfish at the dredge. Pigfish (Orthopristis chrysoptera) were abundant on the dredge but never occurred on the tug. Target pelagic sportfishes such as amberjack (Seriola dumerili) and Spanish mackerel (Scomberomorus maculatus) were common on both wrecks. A total of nine adult sand tiger sharks (Eugomphodus taurus) was also common on both wrecks during June and July 1985.

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POTTERN, GERALD B. North Carolina State University--Status of the Cape Fear shiner Notropis mekistocholas and its species-rich minnow community in a developing watershed.

The potentially endangered Cape Fear shiner Notropis mekistocholas Snelson is confined to a small region near the fall line of the Cape Fear River basin, N.C. Collections failing to yield this fish in recent years prompted a USF&W Service status survey in 1984, which confirmed the suspected loss or severe decline of populations in previously known streams, but revealed low to moderate numbers in adjacent larger river habitat. The status of remaining Cape Fear shiner populations is discussed relative to recent and proposed habitat alterations, and to distributions of certain other minnows among the 22-plus species community of Cyprinoid fishes.

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MAURAKIS, E. G.,[1] W. S. WOOLCOTT,[2] R. E. JENKINS,[3] R. W. WATSON,[4] A. F. HORNE,[5] The George Washington University,[1] University of Richmond,[2] Roanoke College,[3] United States Army,[4] and Colorado State University.[5]--Factors affecting the distribution of fishes in the Rappahannock River, Virginia.

An analysis was made of the effects of elevation, gradient and stream order on the longitudinal distribution of fishes in the Rappahannock River. The distributional pattern appeared to be influenced by all three factors but only elevation proved statistically significant. Numbers of species increased with decreasing elevations from the headwaters in the Blue Ridge (1130 m) to the Piedmont mainstream (117-0 m). Eighty-five species of fishes (62 freshwater, 23 marine) and five hybrids were identified from 365 collections. Addition and replacement accounted for the increased diversity in populations from the mountains to the Piedmont. Replacement of species, especially by marine forms, characterized the population in the tidal reach of the river below the Fall Line.

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MAURAKIS, EUGENE G.[1] and JULES J. LOOS.[2] George Washington University[1] and Potomac Electric Power Company.[2]--Spawning of Hybopsis rubrifrons and Notropis lutipinnis over a Nocomis leptocephalus nest (Pisces: Cyprinidae).

The spawning behaviors of Hybopsis rubrifrons and Notropis lutipinnis over a nest constructed by Nocomis leptocephalus were observed at a water temperature of 20 C. Spawning of fishes over gravel nests constructed by chubs is restricted solely to cyprinids bearing rubric body color. Although xanthic- and ochre-colored species (e.g., Rhinichthys atratulus and Campostoma anomalum) forage nests for eggs or exhibit prespawning nest digging, no cyprinids without rubric-hued bodies have been reported to spawn over chub nests. Hybopsis rubrifrons is the only member of its genus that develops red coloration during the breeding season and is identified here as a nest-spawning associate of N. leptocephalus. A swarm of 30 to 40 H. rubrifrons spawned on the substrate at the nest's base. Spawning occurred when a single male forced a female to the substrate. Notropis lutipinnis (subgenus Hydrophlox) is identified here as an additional nest-spawning associate of N. leptoceplalus. From the base to the crown of the nest, about 45 N. lutipinnis were positioned above H. rubrifrons. Single females spawned with one or two males at a time. Male N. lutipinnis displayed aggression in the form of short parallel swims. The male N. leptocephalus defended its nest from intraspecific males and C. anomalum. This study was supported, in part, by a student research grant from George Washington University Chapter of Sigma Xi.

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MENON, SHAILY A. University of South Carolina--Photoentrainment of activity rhythms of nocturnal rodents in an artificial den recording system.

Photoentrainment of activity rhythms was studied in two den-dwelling nocturnal rodents, flying squirrels(Glaucomys volans) and deermice(Peromyscus leucopus). The experiments tested the hypothesis that brief glimpses of light are used by nocturnal rodents in the photoentrainment of their activity rhythms. The experiments were conducted in simulated dens with darkened nest areas. The animal's movements were recorded by infra-red photocell monitors. Multi-channel recordings of entrainment were made for at least 21 days. For one mouse, light was seen for a maximum of 11 minutes and for a minimum of 3 minutes in any single light period. For one squirrel, light was seen for a maximum of 8 minutes and no light was seen on 12 of the 21 days. The results indicate that under natural conditions, photoentrainment takes place by brief viewings of light which cause instantaneous resets of the animal's clock during the light-responsive phase. The animal apparently free-runs between resets. The number of days between resets depends upon the magnitude of each reset and upon the animal's endogenous period. The endogenous period is observed to undergo modulation as photoentrainment progresses.

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BARRY, RONALD E., and THOMAS E. BAUMMER. Frostburg State College--Spatial relationships of locally sympatric, woodland Peromyscus in western Maryland

A study was initiated to determine the spatial relationships of locally sympatric Peromyscus leucopus (the white-footed mouse) and P. maniculatus (the deer mouse) in a western Maryland woodland. Two-dimensional spatial association between these species, and their microhabitat preferences and use of landmarks, were inferred from ground-based live trapping and releases in an area with 76-percent rock cover. Ten habitat variables were measured within a 2-m radius of each trap location on a 10 x 10, one-hectare grid. Capture frequency of deer mice was positively correlated with the number of rocks and negatively correlated with the number of stems at trap stations. No correlations existed between capture frequency of white-footed mice and the habitat variables we measured. Escapes of individuals up trees occurred in less than 3% of the releases of deer mice and less than 1% of the releases of white-footed mice; most escapes for both species ended beneath rocks. In May through early June and late July through mid August (but not between these periods) the two species were negatively associated at ground level. Apparently the abundance of ground-based refuges and/or nest sites in the rocky substrate permits coexistence of these semiarboreal species without the extensive use of the vertical dimension of the habitat seen in similar studies.

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JACKSON, JEROME A. Mississippi State University--Habitat predictors of present and future status of Red-cockaded Woodpecker colonies.

Thirty-eight Red-cockaded Woodpecker (Picoides borealis) colonies in Mississippi were studied during 1971-1985. Habitat and management activity variables were quantified and colony status was monitored throughout the period. Discriminant function analyses identified sets of variables which could be used to identify colony status in 1972 and 1982. The importance of maintaining an open forest environment for this species was strongly reinforced by the results. The frequencies of management activities that resulted in reduced understory, reduced hardwood components, and thinned pine stands were strongly and positively correlated with active colony status. Variables for which higher values indicated higher understory, greater hardwood component, and denser forest were negatively correlated with active status. Number of cavity trees/colony and proximity of other active colonies were also important to maintenance of active colony status.

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LUUKKONEN, DAVID R., JAMES D. FRASER, and DEAN F. STAUFFER. Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University--Loggerhead Shrike nesting sucess in Virginia.

The Loggerhead Shrike (Lanius ludovicianus) is apparently declining throughout a large portion of its range. Reproduction in a relatively sparse shrike population in Virginia was studied during spring and summar, 1985. Reproductive data were available for 23 shrike nests distributed over four Virginia counties. Clutch sizes, hatching success, fledging rates, and overall nest success were generally similar to reproductive parameters reported in high density shrike populations. Potential factors regulating shrike numbers in Virginia are discussed.

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FRAZER, NAT B. Mercer University--Survival from egg to adulthood in a declining population of loggerhead turtles, Caretta caretta.

This paper presents a methodology for estimating gross survivorship from egg to maturity in decreasing (or increasing) populations of species in which adults and eggs are more easily studied than are juveniles. Values of adult survivorship, fecundity and age at maturity from the recent literature were incorporated into rearranged forms of conventional demographic equations in order to estimate the survivorship from egg to maturity necessary to maintain a population of loggerhead sea turtles, Caretta caretta, at its present rate of decline. Previous methodologies used to estimate survival rates of sea turtle eggs or hatchlings to maturity require the (tacic) assumption that populations are stationary, even though current interest in sea turtle demography stems from the belief that their populations are in decline. Results indicate that previous studies have overestimated the survival rates of eggs or hatchlings to adulthood in sea turtle populations. The methodology may also be useful to students of other species in which adults, eggs or hatchlings are more easily accessible than are juveniles.

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SEMLITSCH, RAYMOND D. Duke University--Costs of predator avoidance in larval salamanders.

Costs of predator avoidance were examined in two species of salamander larvae reared in the presence and absence of a fish predator. The presence of Lepomis macrochirus reduced body size below larvae reared alone by 18% in Ambystoma talpoideum and by 16% in A. maculatum. Survival in the presence of L. macrochirus was also decreased by 61% in A. talpoideum and by 97% in A. maculatum. Activity of larvae in the water column above the benthos was dramatically reduced in the presence of L. macrochirus. Larvae were totally restricted to the leaf litter in the benthos. In the absence of fish, A. talpoideum larvae were more nocturnal whereas A. maculatum larvae were equally active day and night. This experiment suggests that microhabitat shifts to avoid fish predation and presumed restriction of foraging can result in a reduction of growth. A 54% reduction in estimated fecundity can also potentially result from the loss in body size. Optimal life history strategies for prey must balance these costs and benefits of predator avoidance to maximize fitness.

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BASSIN, DENNIS M. University of South Carolina--Temporal and Spatial Relationships in Feeding Patterns of Larval Spot, Leiostomus xanthurus.

Previous studies of larval spot have elucidated major prey species concurrent with morphological changes during metamorphosis. This study is designed to identify trophic movements within the water column during tidal and diurnal fluctuations, as well as lateral movements within the estuary. Data from the analysis of gut contents, along with size classes and sampling locations, will be used to determine statistical significance for several hypotheses concerning movement. This information will in turn be used to construct a model for daily and subdaily feeding patterns.

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HAYES, ROBERT, PETER NIELSEN, and DEAN COCKING. James Madison University, Harrisonburg, VA--Bioaccumulation of mercury by earthworms in South River flood plain soils at Waynesboro, VA.

The presence of significant mercury contamination in bottom sediments, aquatic organisms, and adjacent flood plain soils of the South River has been documented since 1980. This study surveys the extent of mercury accumulation in Lumbricus terrestris L. collected from terrestrial flood plain habitats 3.0-3.5 river miles upstream and downstream from Waynesboro, VA, the original point source of contamination as determined by the Virginia State Water Control Board. Earthworms were collected from forest and field sites with mean soil total mercury concentrations of 22.0 and 16.7 ppm, and control sites with less than 0.5 ppm using ten 0.5 m^2 excavation quadrats at each location. In the laboratory, earthworms were rinsed to remove adhering soil material and retained in deionized water to facilitate voiding of gut contents. Individuals were then composited, lyophilized, and wet digested with a nitric and sulfuric acid mixture. Total mercury concentration for each composite sample was determined using a mercury hydride system with a Perkin-Elmer 3030 atomic absorption spectrophotometer. Statistical analysis of data indicate highly significant differences in earthworm mercury concentration among samples collected from comparable sites. For example, mean mercury concentrations for those living in contaminated old field soils ranged from 4.9-20.9 ppm, in contrast with a mean range of only 0.1-1.1 ppm in earthworms collected from the less contaminated control site.

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PINDER, J. E., III,[1] and P. R. JACKSON.[2] Savannah River Ecology Laboratory[1] and Paine College[2]--Orthopteran grazing on plants with different photosynthetic pathways.

The hypothesis that phytophagous insects avoid consuming plants possessing the C4-dicarboxylic acid photosynthetic pathway in preference to consuming plants possessing only the C3-Calvin pathway was tested for phytophagous orthopterans in South Carolina old-field ecosystems which contain C3 forbs, and C3 and C4 grasses. Orthopterans were collected by sweep nets, and consumption of C3 or C4 species was indicated by the relative abundances of stable carbon isotopes in orthopterans. Most of the 20 orthopteran species fed on C3 plants, but this apparent preference for C3 species may be due to the predominance of forb feeding orthopterans and the absence of C4 forbs in the plant community. Graminivorous orthopterans appeared to prefer C4 species.

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MAHONEY, DIANE L., AND BARBARA E. TAYLOR. Savannah River Ecology Laboratory--Emergence from resting stages and succession of zooplankton in a Carolina bay.
Rainbow Bay is a small (about 1 ha) Carolina bay located in Barnwell County, South Carolina, on the Savannah River Plant. We documented the succession of zooplankton species in Rainbow Bay in 1984 and 1985 through an extensive sampling program. In late 1984 and early 1985 we ran laboratory experiments to measure numbers, species, and times of emergence of zooplankton from resting stages. Plugs of sediment (3 cm x 3 cm area x 2-3 cm depth) were collected when the bay was dry and incubated in water. In the principal experiment, 30 samples from 10 sites were incubated at 10° C. Each day for 20 days, newly emerged animals were removed, identified, and counted. Most of the cyclopoid copepodids and *Diaptomus stagnalis* nauplii emerged within one day after water was added. Most cladocerans, including *Pseudosida bidentata*, *Simocephalus serrulatus*, and *Daphnia laevis*, did not hatch until 10-15 days after water was added. These results predict the succession of species in the natural community during the first month after the bay fills. Later successional events are influenced by other processes, including predation by amphibians.

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WATSON. CHARLES N. East Tennessee State University--The use of pupal exuviae to compare the chironomid communities of a lake and a fishless pond.
This study was carried out to compare the chironomid community of a lake containing a large population of sunfish (*Lepomis* spp.) with that of a nearby fishless pond. Both study sites were located in Bays Mountain Park, Sullivan County. Tennessee. Samples were taken from the pond and from the eastern and western ends of the lake every two weeks from late March through mid-June of 1985. Exuviae were collected by dipping a white enamel pan into floating debris along the shoreline. They were measured and identified to the lowest taxonomic level possible. usually genus or subgenus. Pond and lake samples were compared to see if there were differences in the taxonomic composition and average size of emerging chironomids. The taxonomic composition of both communities was similar. Most of the thirty taxa collected were common to both bodies of water. Pond samples contained a higher proportion of large Chironomini species. but fewer Tanytarsini and Orthocladinae when compared to the lake samples. Selective predation by sunfish on the larger chironomid species in the lake may be responsible for this difference.

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JOHNSON. DAN M. East Tennessee State University--The life history of *Tetragoneuria cynosura* (Odonata: Corduliidae) in Bays Mountain Lake.
Data from eight consecutive years (1977-1985) of monthly sweep-net sampling in the littoral zone of Bays Mountain Lake (Sullivan Co., TN) are combined to show the life history of a 'typical' generation of *Tetragoneuria cynosura*. This typical 'spring' species emerges from late April to late May; the adult breeding season extends through June. Larval population size peaks in mid-July as the new year-class hatches, but declines by 60% before mid-August (mortality attributable to predation by both large dragonflies and sunfish). The population declines gradually through December, more steeply through the winter, and then gradually again until emergence in May. Size-frequency distributions, and dry mass determinations for certain larvae, suggest that 'cohort-splitting' occurs within the junior year-class. About 50% of the individuals in the penultimate instar in September are semi-voltine; the others are fast-growing young-of-the-year entering the penultimate instar at smaller sizes than members of the senior year-class. This size differential seems to be maintained when larvae enter the final instar in October (an hypothesis corroborated by a field experiment conducted from mid-September to mid-October 1985). The size-frequency data suggest that the smaller (univoltine) individuals that reach the final instar suffer more mortality during the winter, and that the survivors among them tend to emerge later. If these trends are corroborated by further experimentation, they may provide insight into the fitness trade-offs involved in the evolution of odonate life-history adaptations.

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STARK, GREGORY J. and JAMES B. LAYZER Tennessee Cooperative Fishery Research Unit, and The Center for the Management, Utilization and Protection of Water Resources--Spatial distribution of crayfish in Mill Creek, Davidson County, Tennessee.
We studied the spatial distribution of the crayfish community on two different levels: longitudinally along the stream's course and on a microhabitat basis along gradients of water velocity and depth, and characteristics of refugia. Two species, *Orconectes shoupi* and an undescribed *Orconectes* species, domi-

nated the crayfish community at five of the six sites sampled. Relative abundance of the species and sex ratios varied between sites and within sites over time. In mid-summer, crayfish densities were high, declining steadily thereafter. Sharing of refugia by more than one crayfish was common at high densities but infrequent at low densities. Length frequency analysis suggests that few individuals live beyond their second summer.

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HACKNEY, COURTNEY T. University of North Carolina at Wilmington--A Note on the Effects of Abnormally Low Temperature on the Carolina Marsh Clam

Populations of the Carolina Marsh Clam, Polymesoda caroliniana suffered high mortality in southeastern North Carolina during the winters of 1983-84 and 1984-85. Adult populations in brackish marshes in the Cape Fear estuary suffered 33% mortality in 1983 and 38% in 1985. Some data suggest that more flooded areas suffered less mortality. A laboratory experiment found that some clams died only after 4 h exposure to 0 to -1° C. LT_{50} occurred only after 6.3 h and no individuals survived 24 h exposure. Cold intolerance is suggested as the primary limiting factor in its northern distribution.

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NAIMO, TERESA J. and ANDREW C. MILLER. Tennessee Cooperative Fishery Research Unit and Waterways Experiment Station--Burrowing Activities of Three Species of Gravel Bar Mussels.

Burrowing activity was observed for three species of freshwater mussels (Quadrula pustulosa, Fusconaia flava, and Obliquaria reflexa). Burrowing activity was separated into two stages: righting time, defined as the time from the extension of the foot until the mussels is upright; and burrowing time, measured as the time from rightedness to 75% shell burial. The type of substrate had no measurable effect on burrowing rates. Mussels that were stressed during transportation or holding exhibited reduced burrowing activity. Although burrowing activity varied among individuals, it was greatest between 1:00 and 6:00 am.

169

RICHARDSON, TERRY D. AND MARSHA STOCK. University of Alabama--The differential occurrence of an epizoic red alga on the stream snails, Elimia clara and E. cahawbensis.

The red alga, Boldia erythrosiphon, has a different frequency of occurrence on two lotic snails, Elimia clara and E. cahawbensis. The alga occurs from November through May in Little Schultz Creek, Bibb County, Alabama, and its growth is largely restricted to the snails' shells with very little growth on bedrock. Samples of the snail populations indicated that E. clara were significantly more abundant than E. cahawbensis ($P<.001$) and that 37.1% of the snails had Boldia on their shells. Also, a t-test of mean proportions ($P<.001$) showed that E. clara had significantly more Boldia than did E. cahawbensis. This association was attributed to the habits of E. clara. It is obvious that growth of the alga on snails provides the alga with a habitat which is less grazed than bedrock, and, since the snails are scrapers, they inhabit areas where there is more sun. Elimia clara tended to be associated with bedrock erosional areas ($P<.001$) while E. cahawbensis was found to be randomly distributed with respect to substrate type and flow regime ($P>.10$). Elimia clara, therefore, may maintain the Boldia population in a preferred microhabitat in terms of flow regime and grazing pressure.

170

SHAFFER, GARY P. and PETER CAHOON. Louisiana State University and University of British Columbia--Extracting information from ecosystems containing high spatial and temporal variability: benthic microfloral productivity.

About 1000 sediment cores from a salt water lagoon were incubated between September 6 and October 6, 1981. Production of the benthic microflora measured using a pair of large cores was compared to production measurements based on the total of 28 small cores taken at varying distances apart. The later adequately represented the different standing crop densities at each area; the large cores did not. Fluctuations in production during the month approximated those measured previously over an entire year. Time series and multichannel information analyses were more informative than stepwise regression analyses because the correlations between productivity and individual environmental factors varied through time. The factors were: chlorophyll a, incident radiation, water temperature, mean tidal range, hours of subaerial exposure, benthic community respiration, pheophytin a/chlorophyll a, and initial dissolved oxygen concentration. Mean tidal range was indirectly the most important factor infuencing production, by governing currents that scoured benthic microflora from the sediments and by exposing the sediments during the day. The information analysis indicated that, for a long range study, considerably more information could be obtained by concentrating all monthly samples into a 14-day interval within each month, rather than sampling throughout the month. The study emphasizes the importance of intensive pilot projects before undertaking yearly or multi-year ecological studies.

171

BARCLAY, LEE A., JR. Tennessee Technological University and U.S. Fish and Wildlife Service--Comparative importance of snag habitat for animal production in coastal plain and Cumberland Plateau streams.

Submerged woody substrates, or snags, have long been recognized as valuable sources of fish habitat and invertebrate production, but quantitative documentation of the significance of such structures to stream ecosystems has been scarce. The major objective of this study was to compare the relative importance of snag habitats in coastal plain streams having sand/mud substrates to those in Cumberland Plateau streams having predominately rock/gravel substrates. This was accomplished through quantitative sampling and analysis of invertebrate habitats, drifting organisms, and fish stomach contents. Invertebrate diversity, biomass, and production were significantly higher on snag surfaces than in sand/mud substrates in coastal plain streams. Snag and cobble/rock surfaces supported similar invertebrate diversities, biomass, and production in Plateau streams, which were significantly higher than measurements of these parameters in either gravel or silt/mud substrates. More species of coastal plain fishes obtained at least 50% of their prey biomass from snags than did Plateau fishes. In general, snags were found to be relatively more important to animal production in coastal plain streams with shifting substrates than in Plateau streams with more stable substrates. These findings indicate that extensive snagging, especially in low-gradient streams, could be devastating to much of the fish community.

172

PATTERSON, SAMUEL G. and J. FRANK MCCORMICK. University of Virginia and University of Tennessee -- Mangrove community boundary interpretation and detection of areal changes on Marco Island, FL.

Export of mangrove leaf detritus into estuarine ecosystems forms the basis of the marine food web along the southwest Florida coast. Presently there are no accurate maps depicting the areal extent of Floridian mangrove communities. South Florida mangrove communities in the Marco Island area were analyzed for boundary interpretation and extent of areal change, in acreages, over time. Medium and high altitude black and white and color infrared aerial photographic imagery were employed for mapping mangrove communities and associated ecosystems. Mapped locations of mangrove community boundaries were entered onto a computer digitized base map to produce statistical estimates of total acreage, community acreage ratios and detection of areal change from 1952 through 1984. From 1952 through 1984 the distribution of mangrove communities changed significantly, while total mangrove ecosystem acreage in the Marco Island area declined by 2,709 acres. Decline in mangrove communities was characterized as follows: fringe mangrove communities declined by 206 acres; riverine communities by 337 acres; black mangrove communities by 1,906 acres; and mixed mangrove communities by 260 acres. Uplands declined by 2,661 acres. Decrease in mangroves and other ecosystems is primarily related to development of Marco Island into residential waterfront property.

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ASB Candidates for Office—1986

The Nominating Committee, composed of Grover C. Miller, Dan K. Evans, and Chairman Charles E. Jenner, has selected the following slate of nominees for the ASB offices to be filled this year. Additional nominations will be received from the floor. Voting will take place during the Annual Business Meeting Friday at 11:15 A.M. in the Russell House Theater.

Biographical sketches of the nominees, presented here, will be in the registration packets.

President-Elect: **Armando De La Cruz,** Mississippi State University
Rebecca R. Sharitz, Savannah River Ecology Laboratory
Vice-President: **William H. Martin,** Eastern Kentucky University
Donald C. Tarter, Marshall University
Treasurer: **Robert L. Beckmann,** North Carolina State University
Executive Committee: **Michael J. Baranski,** Catawba College
(Two positions) **Charles N. Boehms,** Austin Peay University
Nancy C. Coile, University of Georgia
Raymond L. Wyatt, Wake Forest University

Notes

News of Biology in the Southeast

Jon R. Fortman—*News Editor*
Division of Science and Mathematics
Mississippi University for Women
Columbus, Mississippi 39701

ABOUT PEOPLE AND PLACES

Alabama

Auburn University, Department of Botany, Pathology, and Microbiology. *Alvin R. Diamond* recently received an Alabama Wildflower Society Scholarship Award in support of his M.S. thesis research on flora of the Red Hills of Alabama. *Dr. Michel Sancholle,* Associate Professor in the Laboratorire de Cryptogamie at the Universite Paul Sabatier, Toulouse, France, joined the Department as a Visiting Scientist. Dr. Sancholle will be working for six months with *Dr. John Weete* in continuing their collaborative studies on fungal lipid metabolism.

Georgia

Mercer University, Department of Biology. *Nat B. Frazer* has joined the Department as an Assistant Professor. Dr. Frazer received his Ph.D. through the Institute of Ecology at the University of Georgia, and was a Postdoctoral Fellow at the Marine Policy and Ocean Management Center at the Woods Hole Oceanographic Institution. His research specialty is the population of marine turtles. Dr. Frazer is editor of the *Marine Turtle Newsletter* and is one of two USA members of the Wilder Caribbean Sea Turtle (WIDECAST) Recovery Team.

Georgia Southern College, Department of Biology. Seminar speakers for the Fall Quarter Series were: *Dr. Fred Ogunji,* University of Florida; *Dr. Bruce Glick,* Mississippi State University; *Dr. George W. Folkerts,* Auburn University; *Dr. Ken Kasweck,* Florida Institute of Technology; *Mr. Dolan E. Brown,* Georgia Board of Natural Resources; *Dr. Burton Bogitsh,* Vanderbilt University; *Mr. Lester Hardegree,* Armstrong State College; *Dr. Melvin S. Fuller,* University of Georgia; *Dr. Wendell Roelofs,* Cornell University and New York Agricultural Experiment Station; and *Dr. M. S. Silberman,* Emory University.

Wesleyan College, Division of Science and Mathematics. Two new staff members are *Mrs. Katie Floyd,* and the new Chairman of the Division, *Dr. Kenneth Relyea.*

Kentucky

University of Kentucky, The Thomas Hunt Morgan School of Biological Sciences. A one acre urban woodland garden was acquired during the Spring of 1985, to be used as an open air teaching laboratory. The garden, situated only 150 yards from the herbarium and field botany classroom, was started in 1905 by *Clarence Mathews,* the first Professor of Botany and Horticulture, and until 1984, maintained by his daughter Ruth. Under the new management of *Dr. Willem Meijer,* curator of the herbarium, about 380 species of vascular plants were this year tried out or tolerated as weeds in this garden, making it into a small Noah's ark for 100 families and more than 500 species mainly from the surrounding Bluegrass flora, but also from the Appalachian Mountains and the western rim of the mountains.

Louisiana

Louisiana State University, Department of Botany. *Dr. Marshall Sundberg* has been elected as Chairman of the Teaching Section of the Botanical Society of America and has been appointed to the

Education Committee of the B.S.A. *Dr. Thomas S. Moore*, Chairman, has been invited to give talks on "Regulation of Phospholipid Synthesis" in a Phytolipids Symposium at an American Oil Chemists' Society Meeting in Honolulu, Hawaii on May 14–18, 1986, and at the VIIth International Symposium on Plant Lipids to be held in Davis California in July, 1986. *Dr. Bruce Williamson* and *Dr. Nikolaus H. Fischer* (LSU Dept. of Chemistry) have received a three-year grant for a project entitled, "Mechanisms of allelopathy in pine forests of the southeastern Coastal Plain."

Mississippi

Mississippi State University, Department of Biological Sciences. *Dr. Armando A. De La Cruz* has been elected President of the Society of Wetland Scientists for 1985–86 and reappointed Associate Editor of *Wetlands*, the scientific journal of SWS. *Dr. Wyman Dorough* was appointed to the Scientific Review Panel of the National Library of Medicine's Toxicology Data Network and the Defense Logistics Agency's Hazardous Material Information System. *Dr. Jerome A.* and *Bette Jackson* attended the annual meeting of the Wilson Ornithological Society in Boulder, CO and presented a paper on Red-cockaded Woodpeckers. Dr. Jackson served as President of the Society from 1983–85. He also attended the annual meeting of the American Ornithologists Union and presented a paper on colony site changes of Red-cockaded Woodpeckers. He extended a formal invitation for the organization to hold their 104th meeting at Mississippi State University in August 1986. Jerome and Bette Jackson will co-chair the local committee for the meeting. *Robert J. Esher* has received a grant for Mammal Study, Phase II, Mississippi District Barrier Islands, Gulf Islands National Seashore. *Ed Hill* is a co-investigator in the study.

North Carolina

North Carolina State University, Department of Horticultural Science. *Dr. Todd Wehner* is on leave for research with *Drs. Clint Peterson* and *Dick Lower*, at the University of Wisconsin. *Drs. Lech Banasik* and *Zbigniew Strojny* are on leave from the Institute of Pomology and Floriculture, Poland, to engage in research collaboration with *Drs. S. M. Blankenship* and *A. A. DeHertogh*, and *Dr. Paul Nelson*, respectively.

North Carolina State University, Department of Botany. *Dr. Magaly Rincón* recently joined the research group of *Dr. Wendy F. Boss* under an NSF postdoctoral fellowship. Dr. Rincón received her Ph.D. under the guidance of Dr. J. B. Hanson, University of Illinois, studying passive calcium fluxes in corn roots. *Dr. Luis Pena*, a recent graduate of the University of Alberta, has joined the research group of *Dr. Scott Chilton*. Dr. Pena, a chemist, who has previous experience in the isolation of fungal phytopathogens, will work on detection and isolation of toxins involved in determining the host range of fungal pathogens of weeds. Dr. Pena's project is part of a collaboration between Dr. Chilton and *Dr. Gerald Van Dyke* directed toward development of mycoherbicides and fungal agents for biocontrol of weeds in agriculture. *Dr. Ernest D. Seneca*, Professor of Botany and Soil Science, has been promoted to Head of the Department. He succeeds *Dr. Jerome P. (Jerry) Miksche*, who resigned to accept a position with the U.S. Department of Agriculture. A native of Virginia and NCSU faculty member since 1969, Seneca is an authority on coastal ecology. His research and teaching programs on the use of vegetation to stabilize Atlantic and Gulf coast shorelines have received national recognition. He has also been recognized for helping to restore the marshlands along the coast of Brittany (France) following the Amoco Cadix oil spill.

University of North Carolina at Wilmington, Department of Biological Sciences. *Professor Charles M. Fugler* has received a Fulbright Fellowship to West Africa for the 1985–86 academic year and has been temporarily replaced by *Stephen Walker* (Ph.D., North Carolina State University). *Mr. Jack F. Dermid* retired last spring, and *Curt Stager* (Ph.D., Duke University) has assumed his teaching duties. Several grants were received by faculty, including "Colonial Waterbird Population Studies at the Cape Hatteras National Seashore" to *Professor James F. Parnell*; "Role of Benthic Micro-algae in Estuarine Systems" to *Dr. Lawrence B. Cahoon*; "Cytogenetics of Disjunct Populations of Algae" to *Dr. Donald F. Kapraun*; "Relationship Between Fish Aggregations and Current Vortices" to *Dr. David G. Lindquist*; and "Effects of Edaphic Variables on Nesting Succcss in Sea Turtles" to *Dr. Wm. David Webster*. Two faculty members recently received special recognition. *Wm. David Webster* (Ph.D., Texas Tech), was nominated for the Distinguished Dissertation Award given by the Council of Graduate Schools and University Microfilms. *Dr. Joel J. Mintzes* and one of his graduate students, *Mary Arnaudin*, received the Science Education Award of Merit from the National Science Teachers Association. *Drs.*

Wm. David Webster, James F. Parnell, and *Walter C. Biggs* have published a book entitled "Mammals of the Carolinas, Virginia, and Maryland." It is available through the University of North Carolina Press at Chapel Hill.

South Carolina

Furman University, Department of Biology. *Dr. John A. Snyder* has been named Chairman of the Department.

Tennessee

University of Tennessee at Martin, Department of Biological Sciences. A modest Teaching and Research Center is now located on Reelfoot Lake. The facilities are available for small groups and research investigators. An interdisiplinary science course for high school teachers at the Reelfoot Center will be taught in June 1986. Stipends are available. Contact *Dr. Randy Cate* or *Dr. Andy Sliger,* Biology Dept., U. T. Martin.

Virginia

Virginia Commonwealth University, Department of Biology. *Lewis C. Goldstein,* Professor Emeritus of Biology, died on September 29, 1985. Dr. Goldstein received his B.S. and M.S. degrees from the University of Richmond, and his Ph.D. from the University of Virginia in 1947 with research on various invertebrate organisms. He served in World War II as a Navy Lieutenant, and was Chief of Staff of LST Group 95. He came to Virginia Commonwealth (then Richmond Professional Institute) in 1955 as Chairman of the Department of Biology, and was promoted to Full Professor in 1957. From 1967 until 1971 he also served as Assistant Dean of the School of Arts and Sciences, a position to which he devoted all of his time from then until 1975, when he returned to full-time teaching. He retired from VCU on December 31, 1981, due to ill health.

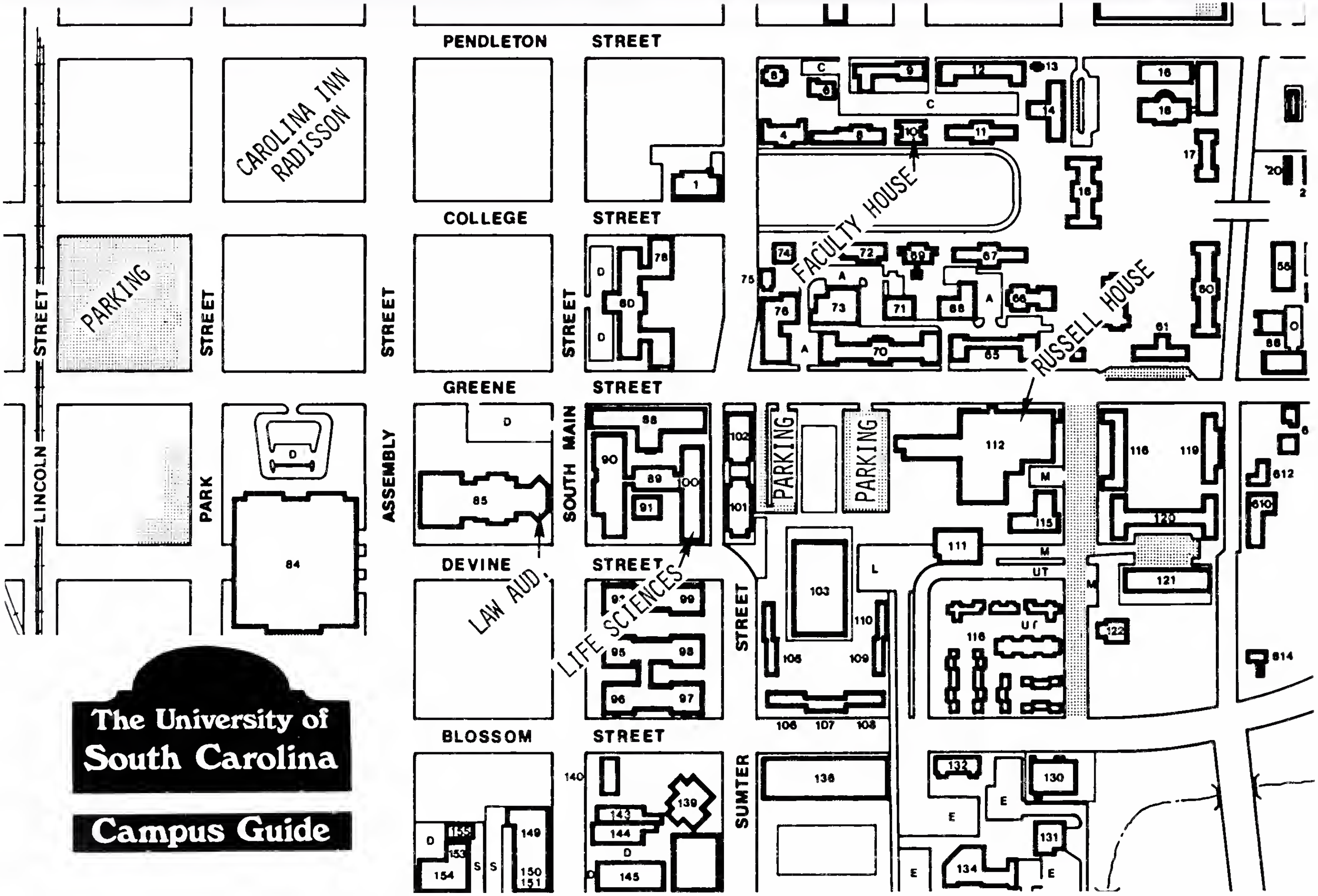
ABOUT MUSEUMS AND BOTANICAL GARDENS

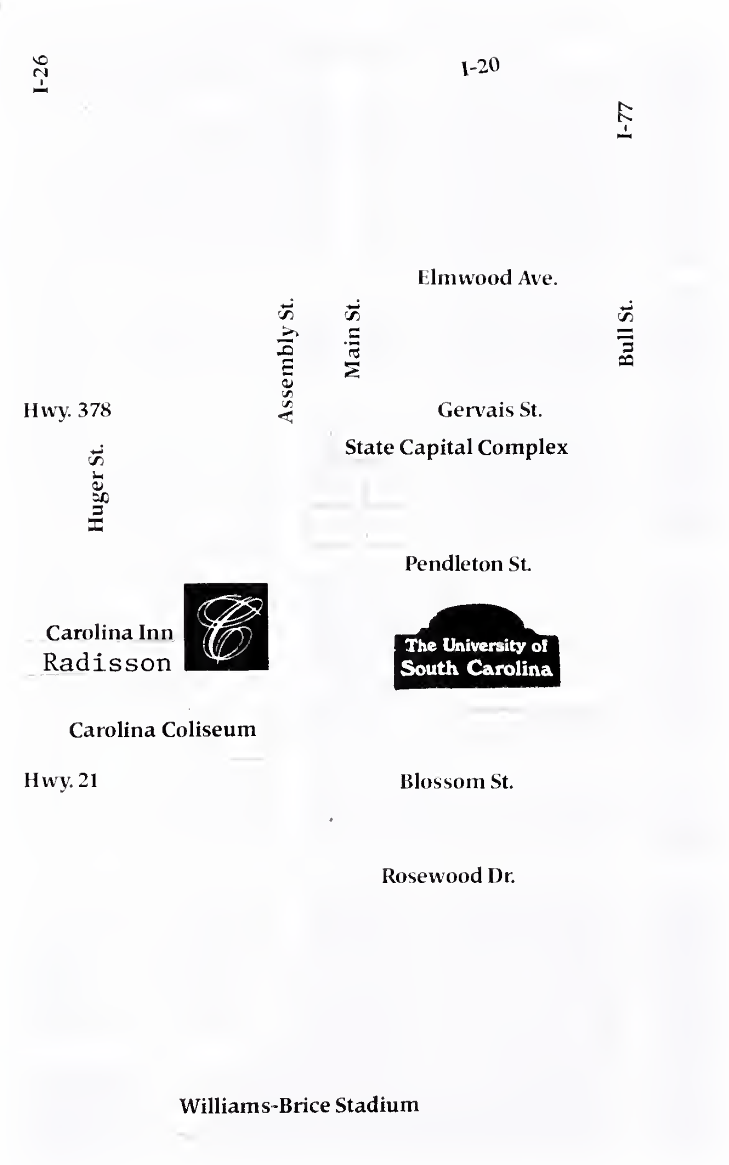
Kentucky

Museum of History and Science, Louisville. The Museum announced the receipt of a $50,000 pledge from BATUS and Brown and Williamson. This pledge brings the Museum capital fund drive within $10,179 of meeting the terms of the city of Louisville challenge grant. The Museum has raised $1,489,821 since the adoption of a long-range plan in March, 1985. Plans call for raising 3.6 million by 1989 to underwrite the addition of a space theater, and open the top floors of the Museum to exhibit space. Though some changes to the floor plan are two years away, the Museum has already started adding new "hands-on" features. There is an expanded arcade of experiments in light and vision, and a mummy's tomb section is planned to open before March 1, 1986. Lobby renovation is in progress to accommodate an increased number of visitors.

The University of South Carolina

Campus Guide

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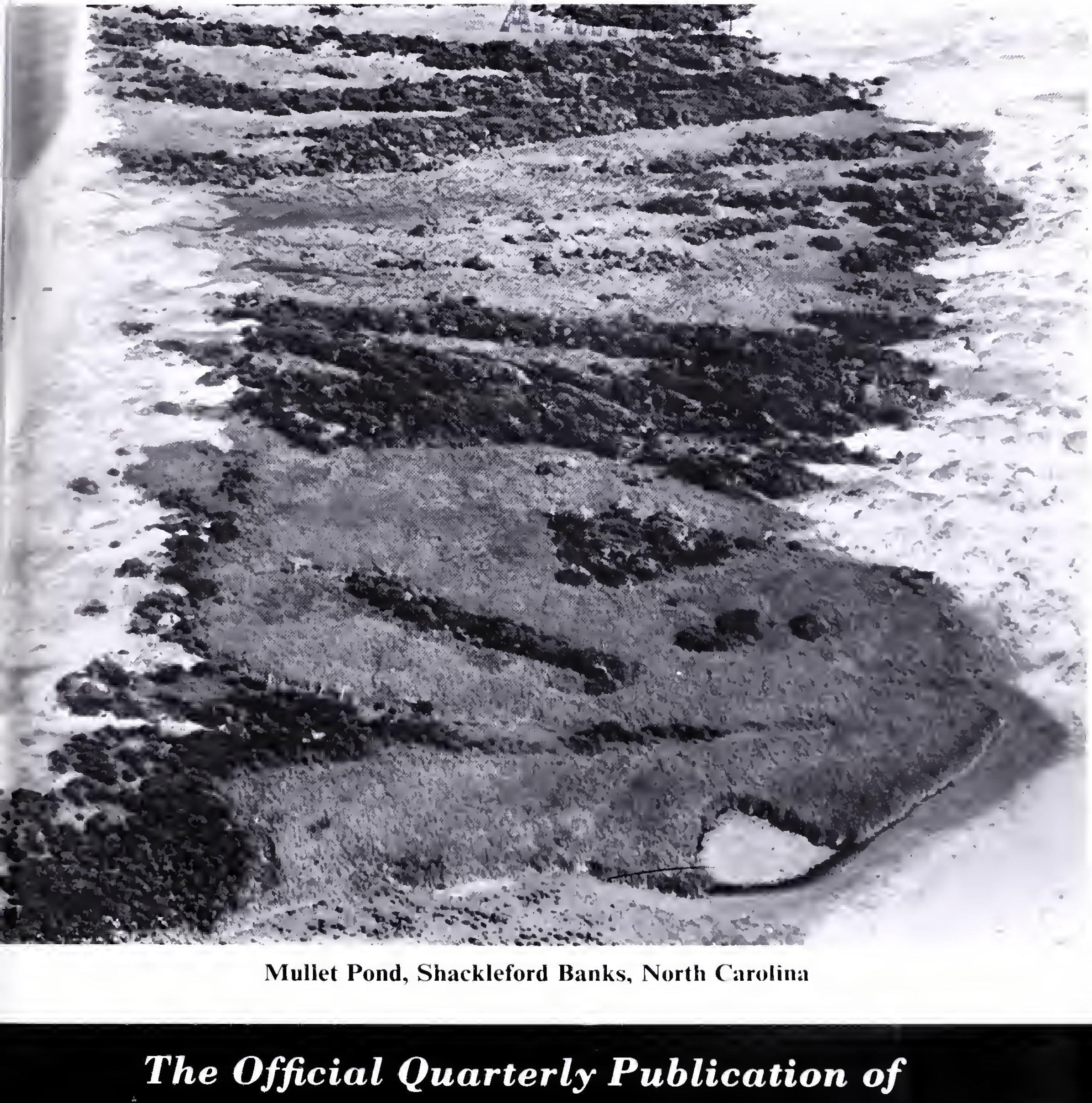

Mullet Pond, Shackleford Banks, North Carolina

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  Carol C. Baskin (1987), Biological Sciences, University of Kentucky, Lexington, KY 40506
  Courtney T. Hackney (1987), Biology, University of North Carolina, Wilmington, NC 28403
  Janice C. Coffey (1988), Science, St Mary's College, Raleigh, NC 27611
  David H. Rembert, Jr. (1988), Biology, University of South Carolina, Columbia, SC 29208
  Michael J. Baranski (1989), Biology, Catawba College, Salisbury, NC 28144
  Nancy C. Coile (1989), Curator, University of Georgia Herbarium, Athen, GA 30605
AAAS Representative, Section G —
  J. Marcus Safley, Soil Conservation Service, P.O. Box 2890, Washington, DC 20013

Volume 33, Number 3 - July 1986

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COVER

View (eastward) of the aging Mullet Pond (lower right tan triangle) located on Shackleford Banks, North Carolina. Note dense algal mat on pond, encroaching sands, overwash, and movement of island to left, all features of a barrier island system. Dark vegetation is ***Q. virginiana.*** Cattails, ***Typha*** sp., large brown area, indicate original extent of Mullet Pond. Refer to Barrier Island Symposium, this issue, for more details on Barrier Island systems of the southeastern United States.

TIME AND PLACE OF FUTURE MEETINGS

1987	April 8–11	University of Georgia, Athens (50th Anniversary)
1988		Co-Hosts Mississippi State University and Gulf Coast Research Laboratory, Biloxi, Mississippi

PATRON MEMBERS

Carolina Biological Supply Co., Burlington, NC
Martin Microscope Company, Easley, SC

Symposium—Abstracts

Barrier Islands Of Southeastern United States

Co-sponsored by
The Association of Southeastern Biologists and
The Southeastern Chapter of the Ecological Society of America

Papers were presented 11 April 1986 during the 47th Annual Meeting of the Association of Southeastern Biologists, University of South Carolina, Columbia, SC, Dr. Paul E. Hosier, University of North Carolina at Wilmington, Convenor.

HOLOCENE HISTORY, MORPHOLOGY, AND HURRICANE RESPONSE OF GULF COAST BARRIER ISLANDS

Dag Nummedal
Department of Geology
Louisiana State University
Baton Rouge, Louisiana

Gulf coast barrier islands are of Holocene age. They differ in evolutionary history, morphology and storm reponse as a consequence of regional differences in relative rates of sea level rise and sediment supply. Along the Texas coast transgressive low-profile barriers are located at all the deltaic headlands. Interdeltaic barriers, in contrast, which have received sand from the eroding deltas, have been regressive since about 3800 b.p. These barriers have developed a high topographic profile with extensive beach and dune ridges. Because of subsidence-induced high rates of relative sea level rise, all Louisiana barriers are transgressive. Deltaic headlands (distributary mouth bars and beach ridge plains) provide the source of sand from where a divergent system of longshore currents supply sand to a symmetrical set of barrier spits and island flanking the rapidly eroding headland. Rapid subsidence transforms the Louisiana barriers into inner shelf transgressive shoals within a few thousand years. The nature of hurricane impact on a barrier, and its post-storm recovery, differ for high-profile and low-profile barriers. On high-profile (regressive) barriers, hurricanes cause beach and foredune erosion with temporary sand storage in the shoreface bar system. Sand returning from the shoreface after the storm provides for beach recovery. On low-profile (transgressive) barriers, in contrast, storms cause extensive overwash, with storage in the lagoon and little potential for recovery.

HOLOCENE HISTORY AND MORPHOLOGY OF ATLANTIC BARRIERS: VIRGINIA-GEORGIA

William J. Cleary
Department of Earth Sciences
University of North Carolina at Wilmington
Wilmington, North Carolina

Ninety-five percent of the barrier islands and spits which comprise the 1100 km long shoreline between Virginia and Florida are Holocene age features. The remainder are late Pleistocene age scarped barrier segments protruding along Holocene barriers in coastal Georgia. Physiographically, the islands range from topographically high, forested beach ridge barriers to low, often narrow overwash-prone, transgressive islands. The later category comprises 77% of the barrier types found within the area.

The wave dominated Virginia and North Carolina coastlines are characterized by transgressive barriers. In the mesotidal settings of South Carolina and Georgia, beach ridge (regressive) barriers became more prevalent and constitute as much as 61% of the barrier shorelines.

Variation in the distribution of these barrier types indicates differences in evolutionary history. The differences in island history are controlled principally by coastwise variations in relative sea-level rise, sediment supply and storm activity. Stability characterizes most of the inlets along the Virginia, South Carolina, and Georgia shorelines; historic inlet zones account for 25%–35% of the barrier trend. Coring and inlet zone maps of North Carolina indicate inlets are more active with inlet fill underlying 75% of some sections. Many low profile islands in Virginia and North Carolina have been impacted by numerous washover events during the past century. Washover related physiography includes a number of identifiable shoreline features which suggest a cyclical nature. Apparently some stretches of the thin stage islands are entering a phase dominated by washovers. Man's interaction may contribute to and accelerate the island narrowing phase.

DISTRIBUTION DYNAMICS OF MARITIME FORESTS

Susan P. Bratton and Kathryn Davidson
The Institute of Ecology
University of Georgia
Athens, Georgia

Investigations of post-colonial disturbance histories for maritime forests on Cape Hatteras, Cumberland Island and Canaveral National Seashores indicate logging of evergreen oaks, grazing and anthropogenic fire have encouraged conversion from hardwoods to pines. Lightning ignited fires are far more frequent at Cumberland and Canaveral than on Cape Hatteras. Natural fires maintain areas of palmetto (*Serenoa repens*), oak and pine scrub. Mature hardwood stands are resistant to burning and inhibit fire even under dry conditions. Release from grazing and burning at Buxton Woods, Cape Hatteras, has modified understory composition. Loblolly pine (*Pinus taeda*), persimmon (*Diospyros virginiana*), and beauty berry (*Callicarpa americana*) have declined in importance, while oaks (*Quercus* spp.) and bays (*Persea* spp.) have increased. Laurel oak (*Quercus laurifolia*) may be better able to regenerate after repeated disturbance than live oak (*Q. virginiana*).

EFFECTS OF MULTIPLE DISTURBANCES ON A BARRIER ISLAND SALT MARSH

Monica Giogel Turner
The Institute of Ecology
University of Georgia
Athens, Georgia

Feral horses (*Equus caballus*) inhabit Cumberland Island, Georgia, and heavily graze the upland portions of the island's salt marshes. This grazing relationship formed the basis of an experimental study, begun in 1983, of the effects of multiple disturbances (grazing, trampling, clipping, and fire) on the marsh. Trampling and burning reduced net aboveground primary production (NAPP) of *Spartina alterniflora* by about 35% while clipping did not reduce NAPP. Standing stocks of live rhizomes decreased with disturbance, as did abundance of *Littorina irrorata*. When disturbances were combined, some responses were non-additive. The potential for synergistic interactions may be important in disturbance-prone systems such as barrier islands. Horses reduced aboveground *Spartina alterniflora* by up to 98% compared to ungrazed plots. A simulation model of carbon flow in the marsh was also developed to explore potential effects of increased grazing. Results suggested that grazing impacts may spread further into the marsh unless feeding preferences of the horses change. Implications of these disturbances for other habitats on the island and for management are discussed.

FISHES, OUTER BANK FRESHWATER PONDS, AND NORTH CAROLINA: AN INTERESTING ASSOCIATION

Frank J. Schwartz
Institute of Marine Sciences
University of North Carolina
Morehead City, North Carolina 28557

Seining the freshwater ponds located on North Carolina's Outer Banks found 29 species of fishes (two of concern) inhabiting 116 of 188 ponds sampled. Twenty-five species (3852 specimens weighing 347.8 kg) occurred in 60 of 96 ponds located between the Virginia state line and Oregon Inlet. Thirteen species (11,131 specimens weighing 12.3 kg) inhabited 56 of 92 ponds from Hatteras Island southward, including Shackleford Banks. Depending on origin, mainland derived ponds were most speciose; southerly accreting area ponds possessed more marine tolerant species. Areas of perturbation, *i.e.*, north of Hatteras, Ocracoke Island, and Core Banks, harbored the poorest faunas. Pond size, depth, water temperature, substrate composition, vegetation, and location were influential and governed a species' occurrence. Fishes were most speciose in mud substrate ponds, regardless of location.

The fish faunas are described from North to South. A species Index of Relative Importance depicts overall and subregional relationships by number, weight, and frequency of occurrence. Gizzard shad and carp, in Nags Head reservoir, comprise 25.5% by weight of the fauna north of Oregon Inlet. Mosquitofish and the sheepshead minnow dominate, by number and weight, all subregional pond faunas. Several areas exhibited pond and species structure aging, similar to other Atlantic and Gulf Coast Outer Bank ponds.

North Carolina's Outer Banks are subject to constant perturbation by sea, wind, and recently man. With time the Banks will move westward and southward. Preservation in a "natural condition" will prolong the existence of fishes inhabiting the Banks. A balance must be maintained, else the wind and sea will have their way and the last word, to the detriment of all.

Association Affairs

1986 MERITORIOUS TEACHING AWARD

Dr. Lafayette Frederick

The recipient of the 1986 ASB Meritorious Teaching Award was Dr. Lafayette Frederick, Professor of Botany, Howard University, Washington, D.C. The award, considered the highest honor ASB confers on a member, consists of a certificate and a check for $1000, generously provided by the Carolina Biological Supply Company. The importance of this award lies not only in the check, but more in the repeated assurance over the years that our society values good teaching and all that goes with it. Furthermore, the award is significant because it is given largely as a result of student support, students whom the recipient has taught, advised, and influenced, and the award reflects those students' satisfaction, appreciation, and affection. Dr. Frederick's formal education included a B.S. degree from Tuskegee Institute, a M.S. in botany from the University of Rhode Island, and a Ph.D. from Washington State University in 1952. Since then, he has pursued a productive research program in mycology with numerous publications. He has also been active in church and community affairs, in teaching undergraduate and graduate students, and in college administration. He was Chairman of the Department of Botany, Atlanta University, for 13 years and is now Chairman of the

Department of Botany, Howard University, a position he has held since 1976. Dr. Frederick has received numerous honors, including the Outstanding Educator of America Award. He has served the Association of Southeastern Biologists as our representative to the AAAS and as our President-Elect and currently our President.

In letters of support for this award, his students and associates have commended him especially for his scholarship, kindness, and thoughtful assistance and inspiration. He has directed the programs of 41 undergraduate students who went on to graduate studies and many satisfying and productive careers; 15 of these received master's and 26, doctoral degrees. He personally was the graduate advisor of 16 master's and 9 doctoral students. Research fields of his former students with doctoral degrees include: mycology, plant pathology, microbiology, plant physiology, systematics, developmental biology and plant anatomy, and cell biology.

His numerous letters of support depict a scholarly professor, one who inspires students to attain unanticipated goals, a teacher with high standards, yet a friend who is kind, considerate, and extremely helpful—in short, a person who has profoundly affected the lives of students for the better.

1986 RESEARCH AWARDS

The **ASB Research Award** to faculty members was presented to Dr. J. S. Fralish, Southern Illinois University at Carbondale. His award-winning paper was "A site specific approach for predicting potential stand composition in the Shawnee Hills Forest of Illinois," the abstract of which is presented below.

Multiple regression models were developed for predicting stand composition index (CI) from site factors in the Shawnee Hills. A CI value for 46 undisturbed, compositionally-stable stands was obtained by multiplying a species relative basal area by its adaptation value. Adaptation values are assigned based on the position of a species maximum basal area value along a stand basal area gradient. A value of 1.0 was assigned to *Juniperus virginiana* which dominated low basal area stands (<15 m^2/ha). *Acer saccharum* was assigned a value of 10 because it dominated high basal area (>25 m^2/ha) stands. Values of 2.3, 5.4, and 8.0 were assigned to *Quercus stellata, Quercus alba,* and *Quercus rubra,* respectively. Three models were developed to predict CI. The best model accounted for 97 percent of the variation in CI and contained soil available water capacity, slope position, aspect, and distanee to the opposing slope as predictor variables. The models were validated using an independent data set and then used to predict CI in successional stands and on highly disturbed sites such as old fields and pine plantations. Predicted CI was then decoded into species components. A biological interpretation was developed based on soil water storage and the influence of other site factors on evapotranspiration loss.

The **Student Research Award,** sponsored by the Martin Microscope Company of Easley, SC, was presented to Michael O. Moore, a graduate student at the University of Georgia. The paper was entitled "A systematic study of selected *Vitis* taxa in the southeastern United States." The abstract is below.

The systematies of North American *Vitis* is presently in a state of taxonomic confusion. All previous attempts at applying modern systematic techniques have failed to resolve these problems. The purpose of this study was to determine if the flavonoid complements of five closely related southeastern *Vitis* taxa could be of use in taxon delimitation. Additionally, principal components analysis was employed in an effort to determine which morphological

characters were most reliable for species characterization. The taxa chosen for study were *V. aestivalis* Michx., *V. cinerea* var. *cinerea* Engelm. ex Millardet, *V. cinerea* var. *floridana* Munson, *V. riparia* Michx. and *V. vulpina* L. The flavonoid results indicate that three distinct chemical groups exist: one producing only flavonols (*V. riparia, V. vulpina*), one producing flavonols and flavones (*V. cinerea* var. *floridana*), and one producing flavonols, flavones and C-glycosylflavones (*V. cinerea* var. *cinerea, V. aestivalis*). Both the flavonoid chemistry and principal components results were most useful in delimiting the taxa. The principal components analyses showed the morphological characters which were most consistent in circumscription of the taxa.

The **Eugene P. Odum Award,** sponsored by the southeastern chapter of the Ecological Society of America, was presented to Gary P. Shaffer of Louisiana State University. The paper, by G. Shaffer and Peter Cahoon of the University of British Columbia, was "Extracting information from ecosystems containing high spatial and temporal variability: benthic microfloral productivity." The abstract is reported here.

About 1000 sediment cores from a salt water lagoon were incubated between September 6 and October 6, 1981. Production of the benthic microflora measured using a pair of large cores was compared to production measurements based on the total of 28 small cores taken at varying distances apart. The later adequately represented the different standing crop densities at each area; the large cores did not. Fluctuations in production during the month approximated those measured previously over an entire year. Time series and multi-channel information analyses were more informative than stepwise regression analyses because the correlations between productivity and individual environmental factors varied through time. The factors were: chlorophyll *a*, incident radiation, water temperature, mean tidal range, hours of subaerial exposure, benthic community respiration, pheophytin *a*/chlorophyll *a*, and initial dissolved oxygen concentration. Mean tidal range was indirectly the most important factor influencing production, by governing currents that scoured benthic microflora from the sediments and by exposing the sediments during the day. The information analysis indicated that, for a long range study, considerably more information could be obtained by concentrating all monthly samples into a 14-day interval within each month, rather than sampling throughout the month. The study emphasizes the importance of intensive pilot projects before undertaking yearly or multi-year ecological studies.

The **North Carolina Botanical Garden Award** was presented to Gary L. Walker, University of Tennessee, Knoxville for his paper "Breeding systems and genetic variability in the population center and disjunct ranges of northern white cedar, *Thuja occidentalis.*"

Northern white cedar (*Thuja occidentalis* L.) is a native conifer of North America, known to horticulturists as arbor vitae. The population center of this species is in eastern Canada where it is an important commercial timber species. In addition to the main range surrounding the Great Lakes region there are disjunct ranges of this species from southern New England southward through the ridge and valley of the Appalachian mountains into Tennessee, and in south central Ohio. Leaf tissue samples collected from stands of white cedar across the population center and in the southern disjunct ranges were analyzed using starch gel electrophoretic techniques to examine allozyme variability in these populations. Results demonstrate the existence of highly variable genotypes within and between stands. Stands were observed to be reproducing sexually, asexually, and in a combination of these reproductive modes. Populations with non-random spatial distributions of genotypes were described by three variable allozyme systems (LAP, PGM, and MDH). These data show possible asexual clustering of alleles into genets effectively preserving genetic variability in these populations.

Graduate Student Support Awards were presented to 14 applicants to help them with costs associated in attending the annual meeting. The number in brackets following each student's address refers to his abstract number as found in the ASB Bulletin 33 No. 2 1986.

Judith L. Robertson, University of Georgia, Athens, GA (6)
Richard R. Bounds, North Carolina State University, Raleigh, NC (16)
David R. Orvos, James Madison University, Harrisonburg, VA (31)
Ma Yun Tao, Western Carolina University, Cullowee, NC (88)
J. Davis Smith, Western Carolina University, Cullowee, NC (90)
Robert Johnson, Western Carolina University, Cullowee, NC (110)
Meta Bonner, North Carolina State University, Raleigh, NC (123)
Deanna Ward, James Madison University, Harrisonburg, VA (138)
Mark S. Peterson, University of Southern Mississippi, Hattiesburg, MS (144)
C. Dianne Stephan, University of North Carolina, Wilmington, NC (149)
Robert Hayes, James Madison University, Harrisonburg, VA (161)
Gregory J. Stark, Tennessee Cooperative Fishery Research Unit, Cookeville, TN (166)
Gary P. Shaffer, Louisiana State University, Baton Rouge, LA (170)
S. G. Patterson, University of Virginia, Charlottesville, VA (172)

1986 COMMERCIAL EXHIBITORS

Addison-Wesley Publishing Co., Atlanta, GA
Associate Microscopes, Elon College, NC
Beckman Instruments Co., Houston, TX
Ben Meadows Co.
Bio-Rad, Richmond, CA
Carolina Biological Supply Co., Burlington, NC (**Patron Member**)
Charles River Laboratories, Wilmington, MA
Conviron, Asheville, NC
Fisher Scientific Co., Pittsburgh, PA
Forestry Suppliers, Inc., Jackson, MS
HALCO, Atlanta, GA
Lab-Line Instrument, Inc., Melrose Park, IL
Martin Instrument Co., Easley, SC (**Patron Member**)
Mettler Instrument Co., Highstown, NJ
Microscope Service and Repair Co., Greenwood, SC
Orion Research, Inc., Marietta, GA
PARCO Scientific Co., Vienna, OH
Prentice-Hall, Inc., Columbia, SC
Sinclairs, Inc., Florence, SC
Tennessee Technical University, Cookeville, TN
Vashaw Scientific, Inc., Norcross, GA
W. B. Saunders Publishing Co., Geer, SC
Wadsworth Publishing Co., Belmont, CA
Wm. C. Brown Co. Publishers, Dubuque, IO
Worth Publishing Co., New York, NY

NECROLOGY

During the past year, the ASB lost the following members by death:

Howard Philipps, Past President ASB, University of South Alabama, Mobile, AL

Dee Saunders Dundee, Professor of Biology, University of New Orleans, New Orleans, LA

THE ASSOCIATION OF SOUTHEASTERN BIOLOGISTS

TREASURER'S REPORT

1 January 1985 - 31 December 1985

I. SAVINGS ACCOUNT			
A. Merrill-Lynch Ready Assets Trust			
Balance January 1, 1985	$ 9,476.92		
Net Transfers to/from Checking	-0-		
Interest Earned 1985	619.99		
	10,096.91		
II. CHECKING ACCOUNT			
Balance on Hand, January 1, 1985	351.43		
A. Receipts			
Regular Dues/Subscriptions	11,639.00		
Annual Meeting	3,087.93		
Bulletin Page Charges	400.00		
Back Issue Sales	61.30		
Endowment	150.00		
Interest	112.19		
TOTAL RECEIPTS		$15,450.48	
TOTAL RECEIPTS AND BEGINNING BALANCE			$15,801.91
B. Disbursements			
1. Membership Cultivation			
Printing & Mailing, Call for Dues	249.23		
Printing & Mailing, Call for Papers	641.17		
		$ 890.40	
2. Publication			
ASB Bulletin (Vol. 32), Printing	9,807.25		
Roll Maintenance for Bulletin Mailing	142.75		
		9,950.00	
3. Office Expenses			
Treasurer	135.51		
Site Visit	1,055.45		
Other Officers	251.07		
Bank Charges	13.16		
		1,455.19	
4. Travel and Related Expenses			
Student Travel Awards	1,744.00		
Honoraria	600.00		
		2,344.00	
5. Research Awards		1,000.00	
TOTAL DISBURSEMENTS			15,639.59
BALANCE IN CHECKING December 31, 1985			162.32
SUMMARY			
CASH IN CHECKING			162.32
CASH IN SAVINGS			10,096.91
TOTAL ASSETS			$10,259.23

RETIRING EDITOR'S REPORT

The 1985 Volume 32 of the Bulletin contained 140 pages, only four more that Volume 31, but cost $750 more to produce. This increase reflects the increase in publication and mailing costs. Both will continue to rise substantially. In fact, publication costs for 1986 are ca. 8½% above those of 1985. Another less expensive printer may be necessary for the future.

Few research manuscripts are being submitted. There are six papers, from last year's symposium on Cedar Glades, that hopefully will appear soon. These are being edited first by Paul Somers. He has some funding available for page charges. The remainder of the cost will be met by ASB, as approved by the Executive Committee.

The recent April 1986 issue is the last one edited by me. I thank the officers and members for their cooperation and for giving me the opportunity to be editor for the last six years. It has been a most rewarding, delightful, and educational experience highlighted by relatively few and minor frustrations. My successor, Dr. Frank Schwartz, will do an excellent job and I feel very good placing the editorship into his hands.

—James W. Harden, retiring editor, 9 April 1986.

ASB OFFICERS, COMMITTEES AND REPRESENTATIVES: 1986-1987

President—Donald J. Shure, Biology, Emory University, Atlanta, GA 30322 (404/727-4209).

President-Elect—Rebecca R. Sharitz, Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29801 (803/725-2472).

Vice-President—William H. Martin, Natural Areas, Eastern Kentucky University, 40475 (606/622-1476).

Retiring President—Lafayette Frederick, Botany, Howard University, Washington, DC (202/636-6929).

Secretary—Sandra T. Bowden, Biology, Agnes Scott College, Decatur, GA 33030 (404/371-6000).

Treasurer—Robert L. Beckman, Botany, North Carolina State University, Raleigh, NC 27695 (919/737-3341).

Executive Committee Members-at Large—

Carol C. Baskin (1987), School of Biological Sciences, The University of Kentucky, Lexington, KY 40506 (606/257-8770).

Courtney T. Hackney (1987), Biology, University of North Carolina at Wilmington, Wilmington, NC 28403 (919/791-4330).

Janice C. Coffey (1988), Science, St. Mary's College, Raleigh, NC 27611 (919/828-2521).

David H. Rembert (1988), Biology, University of South Carolina, Columbia, SC 29208 (803/777-3837).

Michael J. Baranski (1989), Biology, Catawba College, Salisbury, NC 28144 (704/637-4442).

Nancy C. Coile (1989), Curator, University of Georgia Herbarium, Athens, GA 30602.

Auditing Committee—*Chairperson:* Grover C. Miller, Zoology, North Carolina State University, Raleigh, NC 27695-7617 (919/737-2588); Janice C. Coffey, Science, St. Mary's College, Raleigh, NC 27611 (919/828-2521); Jon M. Stucky, Botany, North Carolina State University, Raleigh, NC 27695-7612 (919/737-2227).

Conservation Committee—*Chairperson:* Hal R. DeSelm (1987), Botany, University of Tennessee, Knoxville, TN 37915 (615/974-6208); J. Marcus Safley (1988), Soil Conservation Service, P.O. Box 2890, Washington, DC 20013 (202/447-3921). Gerome Jackson (1989), Biology, Mississippi State University, Box Z, Mississippi State, MS 39762 (601/325-3120).

Local Arrangements Committee for 1987—*Co-chairpersons:* Frank B. Golley, Institute of Ecology, University of Georgia, Athens, GA 30602 (404/542-2968); Richard G. Wiegert, Department of Zoology, University of Georgia, Athens, GA 30602 (404/542-1661).

Meritorious Teaching Award Committee—*Chairperson:* Temd R. Deason (1987), Biology, The University of Alabama, University, AL 35486 (205/348-5960); Charles Boehms (1988), Biology, Austin Peay State University, Clarksville, TN 37040 (615/648-7781); Lafayette Frederick (1989), Botany, Howard University, Washington, DC 20059 (202/636-6929).

Nominating Committee for 1987—*Chairperson:* Charles O'Kelley, Biology, University of Alabama, University, AL 35486 (202/348-5960); James Hardin, Botany, North Carolina State University, Raleigh, NC 27695 (919/737-2226); Rudolph Prins, Biology, Western Kentucky University, Bowling Green, KY 42101 (502/745-5992).

Past President's Council—*Chairperson:* Lafayette Frederick, Botany, Howard University, Washington, DC 20059 (202/636-6929).

Place of Meeting Committee—*Chairperson:* James F. Jackson (1987), University of Southwestern Louisiana, Lafayette, LA 70504 (318/231-6756); Edward Croom, Pharmacy, University of Mississippi, Oxford, MS 38655 (601/232-7152); Edward F. Menhinick, Biology, University of North Carolina, Charlotte, NC 28209 (704/597-2315).

Priorities in Public Affairs Committee—*Chairperson:* George A. Middendorf, III, Zoology, Howard University, Washington, DC 20059 (202/636-6964).

Research Awards Committee-Faculty—*Chairperson:* James W. Ross (1987), Biology, Benedict College, Harden and Blanding Streets, Columbia, SC 29204 (503/256-4220); Hazel R. Delcourt (1988), Biology, University of Tennessee, Knoxville, TN 37915 (615/974-3094); J. Fralish (1989), Forestry, Southern Illinois University at Carbondale, IL 62901 (618/453-3341).

Research Awards Committee-Student—*Chairperson:* Steward A. Ware (1987), Biology, William and Mary College, Williamsburg, VA 23185 (804/253-4458); Frissell R. Hunter (1988), Biology, Savannah State College, Savannah, GA (912/356-2250); Ken R. Marion (1989), Biology, University of Alabama, Birmingham, AL 35294 (205/934-3582).

Graduate Student Support Award Committee—*Chairperson:* Robert E. Daniel (1987), Murray State University, Murray, KY 42071 (502/762-2768); Kenneth W. McLeod (1988), Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29801 (803/450-2472); Don Varny (1989), Biology, Eastern Kentucky University, Richmond, KY 40475 (606/622-2310).

Resolutions Committee—*Chairperson:* Lafayette Frederick, Botany, Howard University, Washington, DC 20059 (202/636-6929); Gerald Cowley, Biology, University of South Carolina, Columbia, SC 29208 (803/777-3167); Rowland M. Shelley, North Carolina State Museum, Raleigh, NC 27611 (919/733-6138).

Editor, ASB Bulletin—Frank J. Schwartz, Institute of Marine Sciences, University of North Carolina, Morehead City, NC 28557 (919/726-6841).

Editor, News and Notes—Jan R. Fortman (1989), Biology, Mississippi University for Women, Columbus, MS 39701 (601/329-4750).

Archivist—Madeline P. Burbanck, Box 15134, Atlanta, GA 30333 (404/373-1413).

AAAS Representative (Section G)—J. Marcus Safley, Soil Conservation Service, P.O. Box 2890, Washington, DC 20013 (202/447-3921).

MERITORIOUS TEACHING AWARD 1987 CALL FOR NOMINATIONS

(Deadline: February 1, 1987)

Through the prestigious annual Meritorious Teaching Award sponsored by Carolina Biological Supply Co., the ASB recognizes excellence in the teaching of biology by one of its members. The Teaching Award Committee asks that you begin to consider nominations for the 1987 award. If you know of a worthy candidate, please take time to make a nomination.

Nominees must be ASB members who are active or recently retired and who have taught biology in a southeastern institution for at least ten years. Among types of evidence of the qualifications of the candidate are the reputation of the candidate as indicated by recognition at his or her institution (important assignments and other contributions specifically related to effective teaching) and the quality of students for whom the nominee has provided inspiration for advanced study and careers in biology.

Nominators should complete the nomination form in the call-for-papers or the one below. Nominators should also obtain a recent curriculum vitae of the nominee, write a letter of nomination, and seek supporting letters from others. All this material should be sent by the nominator to the chairperson of the Teaching Award Committee (below). No supporting letters are to be sent directly to the committee chairperson.

Past and future unsuccessful nominees will not be reconsidered unless a new nomination is made. Nomination materials of unsuccessful nominees will be returned to nominators.

Dr. Temd R. Deason, Chr. Merit. Teaching Award Comm.
Department of Biology
The University of Alabama
University, AL 35486
(205/348-5960)

NOMINATION—MERITORIOUS TEACHING AWARD 1987

NAME ______________________________

ADDRESS ______________________________

____

TEACHING INTERESTS ______________________________

Name of Nominator ______________________________

Address ______________________________

Supporting documentation:
(enclosed)

_____ curriculum vitae

_____ letter of nomination

_____ supporting letters (no. _____)

_____ additional information not in above

1987 Research Awards

The Faculty Research Award Committee Requests that you begin planning to submit a paper for consideration for the 1987 Award. The prize is $500, given by ASB. Three copies of the paper should be sent to Dr. James W. Ross, Biology Department, Benedict College, Harden and Blanding Streets, Columbia, SC (803/256-4220). The deadline is February 1, 1987, and only those submissions postmarked on or before this date will be considered. *Manuscripts should be written in a style and format appropriate for papers submitted for publication.* Papers will be read by eminent scientists outside the Southeast who will judge them on originality, methodology, soundness of hypotheses and conclusions, and significance of contribution to your field. Papers will also be judged for clarity and completeness. Only papers that have not been published prior to the previous annual meeting will be considered. At least one author must be an ASB member in good standing, and the senior author must present the paper at the annual meeting.

The Student Research Award is also $500, sponsored by Martin Microscope Company. The guidelines are the same as those for the Faculty Award stated above except the person presenting the paper must be a student at the time of presentation. Three copies should be sent, by February 1, to Dr. Stewart A. Ware, Department of Biology, William and Mary College, Williamsburg, VA 23185 (804/253-4458). Be sure to enclose a short descriptive resume when submitting the paper for consideration of the award.

The Eugene P. Odum Award is for $100 and a plaque, sponsored by the Southeastern Chapter of the Ecological Society of America, given for the best ecological paper presented by a student at the ASB meeting. The guidelines for this award will be published in a forthcoming issue of the Bulletin.

The North Carolina Botanical Garden, through the Southeastern Section of the Botanical Society of America and the Southern Appalachian Botanical Club, will present an award consisting of a $100 cash prize for an especially meritorious paper presented in the areas of systematics, evolution, or ecology of vascular plants that are native or naturalized in the southeastern United States. Guidelines for this award will be in a forthcoming issue of the *ASB Bulletin.*

Plan now to present a paper at the 1987 meeting in Athens, Georgia, and take advantage of one, or several, or these awards.

POSTER SESSIONS

Poster sessions will be available for paper presentations at the 1987 ASB meetings in Athens, Georgia. The use of posters has become an increasingly popular means of scientific presentation at many national meetings. Poster sessions afford an informal opportunity for direct discussions between participants and attendees. All persons planning to attend the 1987 ASB meeting are thus encouraged to consider this option. Specific instructions for poster presentations will be included with the "call-for-papers" announcement in late summer. Abstracts for posters will be submitted and published in the same general format as past meetings.

APPLICATION FOR ASB MEMBERSHIP

Give copies of this to your students, colleagues, and your school librarian.

Fill out blanks and enclose check or money order for one year's dues and mail to Dr. R. L. Beckmann, Dept. of Botany, N.C. State Univ., Raleigh, N.C. 27695-7612. Please include phone number on application.

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Book Reviews

Tobey, F. J. 1985. **Virginia's Amphibians and Reptiles—A Distributional Survey.** Virginia Herpetological Survey. Route 1, Box 381, Purcellville, VA 22131. 114 pp. To be reissued in September.

The title of this book describes the contents very well. The author presents 135 dot distribution maps that indicate specific county records for each of the amphibians and reptiles that occur within the state. The author has utilized collection records from a number of sources, but primarily from records obtained from professional and amateur herpetologists over the past 20 years. Although the Virginia Herpetological Society has issued special publications dealing with a particular group of amphibians and reptiles, this is the first complete listing for all groups.

While the main part of the book is devoted to the actual distributional maps for each species, the author also presents short sections on the history of Virginia herpetology, physiographic provinces, and drainage systems of the state. There are no illustrations other than those of venomous snakes, no taxonomic keys, or descriptive text, but the author handles this shortcoming in a very novel way. The appropriate pages for this information in Conant's (1975) ***A Field Guide to Reptiles and Amphibians and of Eastern and Central North America*** are listed in the index. Annotations on each species distribution map give additional information that pertains directly to Virginia specimens.

Though the distributional information presented in this publication is incomplete, the timing of this publication is excellent. The Virginia Fish and Game Commission has commissioned funds for a complete work on the amphibians and reptiles of Virginia. This current book will allow individuals to see where there are gaps in the distributional records of various species, and perhaps fill in these gaps before the upcoming work is finished.

This book is an excellent buy for anyone interested in the geographical distribution of the Virginia herpetofauna. *(Don Merkle, Longwood College, Farmville, VA 23901.)*

News of Biology in the Southeast

Jon R. Fortman—*News Editor*
Division of Science and Mathematics
Mississippi University for Women
Columbus, Mississippi 39701

ABOUT PEOPLE AND PLACES

Alabama

Auburn University, Alabama Cooperative Fish and Wildlife Research Unit. *Dr. John S. Ramsey* is leaving the Deep South after 19 years as Leader of the Alabama Cooperative Fishery Research Unit, U.S. Fish and Wildlife Service. He has taken over direction of the Aquatic Resources Section of the Iowa Cooperative Fish and Wildlife Research Unit at Iowa State University.

Georgia

Emory University, Biology Department. *Victoria Finnerty* published a paper entitled "Molybdenum hydroxylases in Drosophila, III. Further characterization of the low xanthine dehydrogenase gene" in Biochemical Genetics, Vol. 24, August 1986. *Darrell R. Stokes* attended a symposium on Nerve-Muscle Interactions sponsored by the American Society of Zoologists and presented the paper, "Insects muscles innervated by single motoneurons: structural and biochemical features."

Shorter College, Science Department. Faculty and Alumni honored *Drs. Philip Greear* and *Lewis Lipps* at a dinner on May 10, 1986. Also a *Lewis Lipps/Philip Greear* Scholarship Fund has been established. **Georgia Southern College, Biology Department.** *Dr. Kishwar Maur* presented a paper on "Histopathological Studies of Soybean Stem Canker Disease" at the Georgia Association of Plant Pathologists.

Louisiana

University of New Orleans, Department of Biological Sciences. The department has established the *Dee Saunders Dundee* Memorial Graduate Student Scholarship and Research Fund. *Dr. Dundee,* who died in May of 1985, was an active member of ASB and a founding faculty member at UNO. Graduate students doing research in field biology will be supported by this scholarship. Students interested in applying to the program and for a scholarship should contact *Dr. Robert Cashner,* Department of Biological Sciences, UNO, Lake Front, New Orleans, LA 70148. Contributions to this fund from friends and colleagues of Dee are appreciated.

Southern University, Center for Small Farm Research. *Dr. Jay V. Huner* has been named co-editor of the quarterly newsletter of the International Association of Astacology, along with *Dr. James F. Payne* of Memphis State University. The association's members are crawfish specialists from throughout the world, and *Dr. Huner* is a senior investigator specializing in crustacean aquaculture at Southern. For more information about this association, contact *Dr. Huner* at P.O. Box 11170, Southern University, Baton Rouge, LA 70813, (504)771-5110.

Mississippi

Gulf Coast Research Laboratory, Ocean Springs. Research being conducted at GCRL hopefully will open the door for the expansion of the local softshell blue crab industry. The Mississippi–Alabama Sea Grant Consortium, State matching funds, and GCRL inkind support will provide funds for *Harriet Perry* and *Dr. John A. Freeman* (Univ. of South Alabama) to continue their three-year research effort in the use of hormones to accelerate the blue crab's molt cycle. *Dr. Joanne L. Shultz,* GCRL ichthyologist and planktologist *Dr. John P. Steen* will devote the final year of a three year research project on red drum, a highly prized sport and commercial species in Gulf waters. During 1986, they will analyze over 600 red drum larvae samples collected during 11 research cruises over the past two years. *Dr. David Cook* and *Angela Dicharry* will complete a two-year research program to examine the effects of storage temperatures and handling procedures on bacteria levels in unshucked oysters. In the past, Mississippi's oyster industry has suffered severe economic losses when oysters from approved waters arrived on the wholesale market on the East Coast with elevated fecal coliform levels. Wholesalers assumed that the oysters were from polluted waters and destroyed them. The research done thus far may show that harvesting from approved areas and sanitary handling could still result in oysters that exceed the fecal coliform standard. In that case, fecal coliform levels would have no relation to sanitation.

North Carolina

Elon College, Biology and Allied Health. *Dr. W. David Sissom* (Ph.D. Vanderbilt University) has joined the Faculty as a zoologist, replacing retiring professor *V. F. Morgan. Dr. Sissom's* interests deal with the systematics of scorpions.

Tennessee

The University of Tennessee, Knoxville, Department of Botany. A course consisting of lecture—discussions and laboratory exercises in most aspects of plant cell and tissue culture will be held on campus August 18–29, 1986. This course is designed for persons with a degree in science or experience in plant tissue culture who need a thorough knowledge of and training in plant cell and tissue culture. The course has been evaluated and certified by the Tissue Culture Assn., Inc. The fees for the course will be $1100. For further information contact *Dr. Donald K. Dougall*, Botany Dept., The University of Tennessee, Knoxville, Tenn. 37996-1100 (615/974-2256).

ABOUT MUSEUMS AND BOTANICAL GARDENS

Anniston Museum of Natural History. Some of the programs planned for the summer are: "1985, Science in Pictures," Wildlife lecture on "Birds of Prey" by *Pete Conroy*, "Sculptures by *Frank Fleming*," Lecture on "Mammals," Overnight river trip—easy canoeing through the wilderness, with emphasis on river mammals, reptiles, fish and birds, "Art and Artists of the South: The Robert P. Coggins Collection."

Florida

Marie Selby Botanical Gardens, Sarasota. Two events of interest are scheduled for July: on July 4th, the Gardens will stay open into the evening in order to provide a waterfront site for viewing Sarasota's annual fireworks display. On Saturday, July 26, the annual mid-summer Plant Fair will be held. The Gardens' one-day bonanza will be held from 10 A.M. to 5 P.M.; there is no admission and all of the Gardens' attractions will be open for the enjoyment of patrons attending the fair.

Kentucky

Museum of History and Science, Louisville. Two large grants have been received for the construction of an IMAX space theatre. A $500,000 matching grant from the Brown Foundation was received in December 1985, followed by $100,000 in grants from the George Norton Foundation and *Mrs. Jane Norton*. The goal is $3.6 million and $2,114,721 has been raised to date. A new staff member has been added to the museum, *Ms. Lane Light* who will serve as Development and Special Projects Manager, coordinating fund-raising and special membership events as well as exhibits-related festivals. South Central Bell has given a gift of $50,000 to be used to sponsor a permanent exhibit titled "Pioneers in Sound and Communication." In response to popular demand, the newest educational offering is a series of "Museum to Go" kits. According to Education Coordinator *Amy Lowen*, the kits were created to correspond with the schools' curriculum, as well as topic interest. Many classes said they would like to visit more, but financial or schedule conflicts prevented regular visitation. Kits are available for six topics: Prehistoric Indians, American Indians, Animal Adaptations, Rocks and Minerals, Fossils, and Granny's Trunk. History and science are both represented in the contents of each portable kit.

Louisiana

Lafayette Natural History Museum, Planetarium and Nature Station. Some of the programs for this summer include a photograph exhibit by *Ginette Vachon,* a Louisiana Prairie exhibit, "The Sky Tonight" and "The Last Question" at the Planetarium, as well as guided tours of the Nature Trails, Bird walks, and a night hike in the Fall. The Louisiana Native Crafts Festival will be held at the Museum on September 20–21, 1986.

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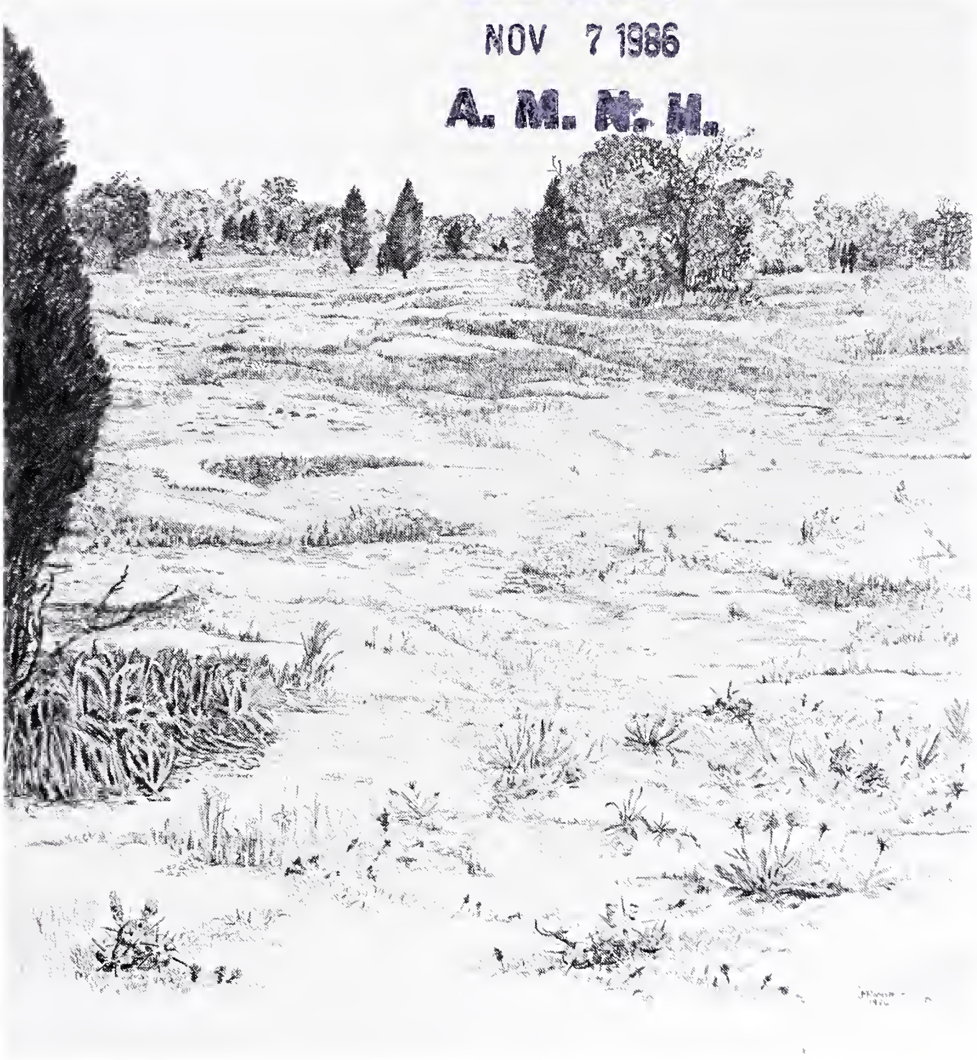

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TIME AND PLACE OF FUTURE MEETINGS

1987	April 8–11	University of Georgia, Athens (50th Anniversary)
1988	Co-Hosts:	University of Southern Mississippi and Gulf Coast Research Laboratory, Biloxi, Mississippi

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SYMPOSIUM

BIOTA, ECOLOGY, AND ECOLOGICAL HISTORY OF CEDAR GLADES

Co-sponsored by the

Association of Southeastern Biologists and
Southeastern Chapter of the
Ecological Society of America

Paul Somers
Tennessee Department of Conservation
Guest Editor and Convenor

Elsie Quarterman, Ph.D.

DEDICATION

This special issue is dedicated to Dr. Elsie Quarterman, Professor Emeritus, Vanderbilt University, Nashville, Tennessee, who 40 years ago initiated the first comprehensive investigations of cedar glade communities. Her knowledge of the glades and personal enthusiasm have stimulated numerous students to conduct further research on their ecology. In addition, she worked tirelessly and with considerable success for their preservation by private and governmental conservation groups. As a result, all are indebted to her for this pioneering work and foresight.

BIOTA, ECOLOGY, AND ECOLOGICAL HISTORY OF CEDAR GLADES

INTRODUCTION

Elsie Quarterman

Vanderbilt University

Most physiographic regions contain some topographic, floristic or faunistic areas that are of special biological interest. In Middle Tennessee, the unique areas are those known locally as cedar glades. These were first described by early geologists (Galloway 1919; Safford 1869) and by a nineteenth century botanist, Augustin Gattinger (1887, 1901). Glades occur principally in the physiographic region known as the Central Basin of Tennessee, which is open-ended in the direction of Alabama. Some glades occur there, as well as in Northwest Georgia and occasionally in Kentucky.

Cedar glades occur most often in Middle Tennessee on thin plates of more or less horizontally bedded Lebanon that is vertically fissured, so that solution holes form readily. The soil mantle varies in depth from nothing on exposed rock, through thin gravelly layers not more than about 5 cm deep, to soil about 20 cm deep. Soil depth greater than 20 cm, including that in potholes and crevices, supports thickets or woods in which *Juniperus virginiana* L. is a major dominant.

> The climate is wet in winter and early spring and dry in summer. This, coupled with the shallow soil and a fairly impervious substrate, makes for very different hydrologic seasons.
>
> The flora of the open glades includes plus or minus 15 endemic and near-endemic species, a few prairie disjuncts and a large number of rather generally distributed but habitat-restricted species. The presence of a cluster of endemics such as occurs in cedar glades, or on granite outcrops, or serpentine barrens plainly says that here, in this place, at some time remote or recent or both, the processes of evolution have been particularly active or else the processes of extinction have been particularly slow.

The thinnest soil of glades is dominated in the wet winter and spring season by winter annuals, *Leavenworthia* spp., *Arenaria patula* Michx. and *Sedum pulchellum* Michx. In summer, *Sporobolus vaginiflorus* (Torr.) Wood and blue-green algae are usually dominant, with occasional sites dominated by *Cyperus inflexus* Muhl. and *Talinum calcaricum* Ware.

Glades whose soil varies in depth from more than five to about 20 cm are dominated by two grass species, *Sporobolus vaginiflorus* and *Aristida longespica* Poir., a legume, *Dalea gattingeri* (Heller) Barneby and a moss, *Pleurochaete squarrosa* (Brid.) Lindb. Many other species occur in this zone as seasonally dominant, often sporadic, populations. Floristically, these grassy glades are the richest of the various glade zones. Soil is covered in summer by growing plants and in winter by standing litter of seed plants and by the vegetatively active moss.

> In seeking to understand the relationships of the glade community components and thus, ultimately (and perhaps optimistically), those of the glade

ecosystem previously described (Quarterman 1950a, 1950b), graduate students at Vanderbilt and I began to investigate the life history and community relationships of some of the glade endemics, near-endemics and characteristic species. Starting points were seed germination and life cycle studies, interaction of species with physical factors of the environment, of which moisture and light were of obvious importance, and interrelationships of species with other biotic components of the ecosystem. My own interest in allelopathic possibilities (Quarterman 1973) led to a consideration of allelopathy in most studies.

Zager, Waits (Zager *et al.* 1971) and Bangma (1966) worked on the phenology, seed germination, temperature requirements and allelopathic effects of *Leavenworthia stylosa* Gray, a winter annual of very shallow soils. After graduation, Baskin and Baskin (1971, 1972a, 1972b, 1972c, 1973) continued to study *Leavenworthia* species, refining and expanding the earlier work. They also published papers too numerous to list here on seed germination of other glade species. These and other reports dealing with seed germination of glade species have been summarized in tabular form (Hemmerly and Quarterman 1978).

David Mulcahy, under the direction of Dr. R. B. Channell, worked out the reproductive biology of the heterostylous species, *Oxalis priceae* Small. This taxon is comprised of three subspecies, one tristylous and two distylous ones lacking the mid-style. Of these latter two, subspecies *priceae* is a glade endemic. Mulcahy's data (1964) indicate that its clonal growth habit promotes inbreeding, which may have a causal relationship to loss of the mid-style form.

Harry Sherman, also under the direction of Dr. Channell, worked out the taxonomy of the genus *Schoenolirion* including the glade species, *S. croceum* A. Gray (Sherman 1969).

Johnnie Breeden (1968) did a comparative morphological/ecological study of eight populations each of the narrowly restricted *Dalea* (*Petalostemon*) *gattingeri* (Heller) Barneby and the widely distributed *D. purpurea* A. Vent. and of two populations of naturally occurring hybrids between them. He proposed, on the basis of intraspecific groups demonstrated in both species, entry of *Dalea* (*Petalostemon*) into Middle Tennessee during the Pliocene and the origin of *D. gattingeri* during the formative stages of the Central Basin.

Jerry Baskin demonstrated that *Psoralea subacaulis* T. & G., a herbaceous perennial that is an aspect dominant in open grassy glades, is adapted to the glade environment in several ways (Baskin and Quarterman 1968, 1970). It evades the rigors of both wet and dry seasons by completing the active part of its life cycle during spring and early summer. Although seeds are shed in May or June, germination does not occur until the following spring when conditions are favorable for seedling establishment and by which time the psoralen that inhibited germination has been leached from the seeds (Baskin *et al.* 1967; Baskin and Murrell 1968). It is an obligate heliophyte, for which the open glade habitat is suitable.

Carol Caudle Baskin investigated the ecological life cycle of *Astragalus tennesseensis* Gray, a near-endemic whose range extends into Illinois where it is now exceedingly rare and historically extended into Indiana. *Astragalus tennesseensis* is usually limited in its local distribution to the transition zones between thickets or woods and open grassy glades where neither light nor moisture conditions are optimum for it. Moisture, however, is insufficient where light is optimum and vice versa, so the compromise is to grow at the edge of its tolerance for both factors (Baskin and Quarterman 1969, Baskin *et al.* 1972).

Stewart Ware, on beginning a study of *Talinum* species, determined that the glade *Talinum* was new to science and described it as *Talinum calcaricum* (Ware 1967). He made a study of the newly described species, dealing with its tolerances and susceptibilities to certain physical and biotic factors of the habitat (Ware 1969; Ware and Quarterman 1969). The tolerance of *T. calcaricum* for the severe conditions of the shallow soil ecotone is related to the timing of its life cycle events and to its resistance to drought.

Barbara Turner compared the phenology and seed germination of two populations of *Dodecatheon meadia* var. *meadia* L., one each in a woodland and cedar glade habitat. These were shown to have a sufficient number of genetically fixed ecological differences to assign ecotypic status to them (Turner and Quarterman 1968).

Turner also conducted an experimental field and laboratory study of the effects of *Dalea* (*Petalostemon*) *gattingeri* metabolites on the local distribution and growth of *A. patula* (Turner and Quarterman 1975). She showed that, in addition to phenology and seasonal distribution of rainfall, inhibitors leached from living *D. gattingeri* plants and from their litter completely inhibited germination of *A. patula* where the silt/clay fraction of the soil was high, but merely stunted *A. patula* growth where the soil was mostly gravel, thus strongly influencing the distribution of *A. patula* in cedar glades.

The life cycle strategy of a Federally endangered glade species, *Echinacea tennesseensis* (Beadle) Small was investigated by Thomas E. Hemmerly (1976), who will report on his work in these proceedings.

It is most gratifying to see that much high quality work on cedar glades continues to be done, as evidenced by the presentations included here.

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VEGETATIONAL HISTORY OF THE CEDAR GLADES REGIONS OF TENNESSEE, KENTUCKY, AND MISSOURI DURING THE PAST 30,000 YEARS

Hazel R. Delcourt, Paul A. Delcourt,
Gary R. Wilkins, and
E. Newman Smith, Jr.

Program for Quaternary Studies of the Southeastern United States
Departments of Botany and Geological Sciences and the
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ABSTRACT

Late-Quaternary paleoecological sites in the Ozark Plateaus of Missouri and Interior Low Plateaus of Tennessee and Kentucky provide information concerning changes in vegetation, climate, hydrology, and edaphic conditions over the past 30,000 years. This information is directly useful in interpreting changes in area and distribution of "glades," or openings in the forest on outcrops of limestone and dolomite, that today provide the distinctive habitat for numerous endemic species of vascular plants. From 30,000 years BP to 24,000 years BP, climates were warm and dry, groundwater tables were low, and open jack pine woodland occupied the Ozark Plateaus, while a mixture of northern conifers and hardwoods occurred on the Interior Low Plateaus. From 24,000 years BP to 12,500 years BP, climates were cool and wet, groundwater tables were relatively high, regional vegetation was boreal coniferous forest, and cedar glades habitats probably were reduced in areal extent. With minor climatic warming 16,500 years BP, cool-temperate deciduous trees began to spread northward. During the Holocene, after 12,500 years BP, deciduous forest became predominant. Climatic warming and drying resulted in a peak in the number and areal extent of cedar glades between about 8500 years BP and 4500 years BP. Indian burning and forest clearance may have maintained open habitats suitable for cedar glades during the last 4500 years.

INTRODUCTION

Cedar glades are openings within sparse, early-successional woodlands of red cedar (*Juniperus virginiana* L.; nomenclature follows Fernald 1970, unless otherwise indicated). In eastern North America, cedar glades occur primarily within the regions of the Ozark Plateaus of Missouri and Arkansas and the Interior Low Plateaus of Tennessee, Kentucky, and Alabama. Cedar glades habitat is typically characterized by shallow soil or bare rock representing exposures of limestone and dolomite bedrock of Cambrian, Ordovician, or Mississippian age. In the Central Basin of Middle Tennessee, cedar glades occur primarily on outcrops of Ordovician-age Lebanon limestone that occupy only about 5% of the landscape (Quarterman 1950a, 1950b; Baskin and Baskin 1985). These sites provide a distinctive, a winter-wet, summer-dry habitat for numerous endemic species of vascular plants (Quarterman 1950a and b). The cedar glades flora thus includes both winter annuals and drought-tolerant prairie forbs and grasses (Baskin and Baskin 1985; see also Baskin and Baskin, this volume).

Speculations concerning the areas of origin as well as the distributional history of plant species that are today restricted to or particularly characteristic of the cedar glades have been based upon interpretation of their modern distributions as well as their phylogenetic relationships to related species (*e.g.* Rollins 1963). However, climate and vegetation have changed dynamically on time scales of hundreds to thousands of years, reflecting changes from glacial to interglacial conditions during the Quaternary Period of geologic history (Delcourt and Delcourt 1987). Therefore, the modern distributions of plant taxa may not reflect their distributional history. Further insights into the history of the cedar glades flora can be gained by evaluating long-term changes in regional environmental conditions. Changes in groundwater table, for examples would have affected the area and number of exposures of limestone and dolomite; changes in mean annual temperature and in seasonality of climate would alter the rate of weathering of exposed rock by changing the frequency and intensity of freeze–thaw cycles as well as changing the annual distribution of precipitation that is today critical for successful reproduction of many of the cedar-glades endemics.

Although several plant genera endemic to the east-central United States, for example, *Leavenworthia* spp. are distributed broadly throughout the Interior Low Plateaus (Solbrig and Rollins 1977), their populations are restricted within that region to very localized habitats. In addition, many cedar glades endemics are insect-pollinated (Baskin and Baskin 1985), and their pollen grains tend to be both produced in small quantities and are probably not dispersed widely beyond the local, open glade into the neighboring woods of red cedar. Therefore, tracing the history of changes in flora and vegetation on any specific cedar glade site would require pollen and plant-macrofossil analysis of sediments obtained from a small, permanently wet basin in close proximity to cedar glades habitats. Because soil-moisture deficits in summer are accentuated on the thin (typically <25 cm thick) soils of glades associated with outcroppings of carbonate rock (Baskin and Baskin 1985), permanently-wet ponds are scarce, and no local-scale palynological studies have yet been undertaken in cedar glades habitats.

Studies in late-Quaternary pollen and plant-macrofossil analysis that have been completed to date in Missouri, Tennessee, and Kentucky have been derived from sediments of sinkhole lakes or stream terraces, and thus document the regional character of vegetational development and climatic change over as much as the past 30,000 years (Delcourt and Delcourt 1985a). This regional network of paleoecological sites allows interpretation of broad changes in temperature, position of groundwater table, and gradients in soil moisture that have direct implications concerning changes in both distribution and areal extent of the cedar glades flora and vegetation. The intent of this paper is to summarize both published and unpublished palynological data from paleoecological study sites located in the Ozark Plateaus of Missouri and the Interior Low Plateaus of Kentucky and Tennessee (Fig. 1). This summary provides a context for interpreting the influence of late-Quaternary climatic, geomorphic, hydrologic, and vegetational changes upon cedar glades habitats.

VEGETATIONAL AND CLIMATIC HISTORY OF THE OZARK PLATEAUS

Pomme de Terre River Terraces, Western Missouri

Spring deposits studied by King (1973; King and Lindsay 1976) from terraces along the Pomme de Terre River of west-central Missouri (Fig. 1) were radiocarbon-dated as ranging in age from over 40,000 years BP (years Before Present)

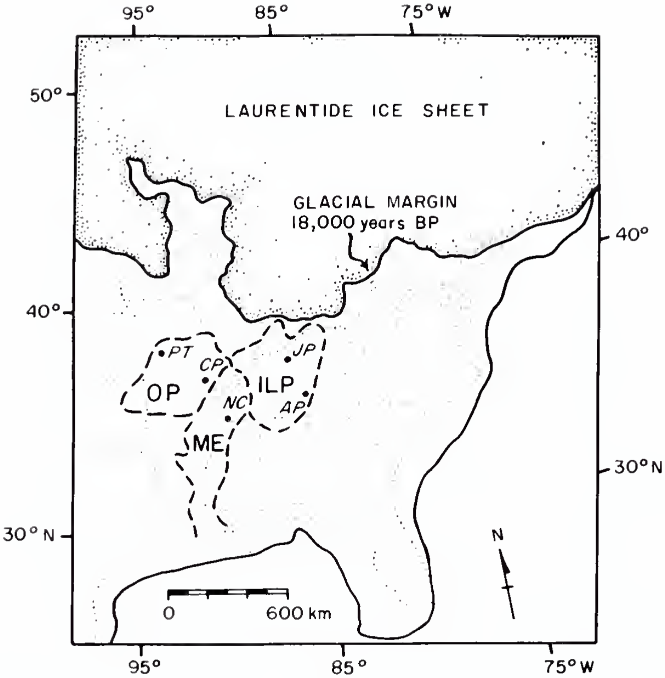

Fig. 1. Location map for sites discussed in text. *AP* = Anderson Pond, Tennessee; *CP* = Cupola Pond, Missouri; *JP* = Jackson Pond, Kentucky; *NC* = Nonconnah Creek, Tennessee; *PT* = Pomme de Terre River, Missouri. Dashed lines indicate three physiographic provinces: ILP = Interior Low Plateaus; ME = Mississippi Embayment; OP = Ozark Plateaus.

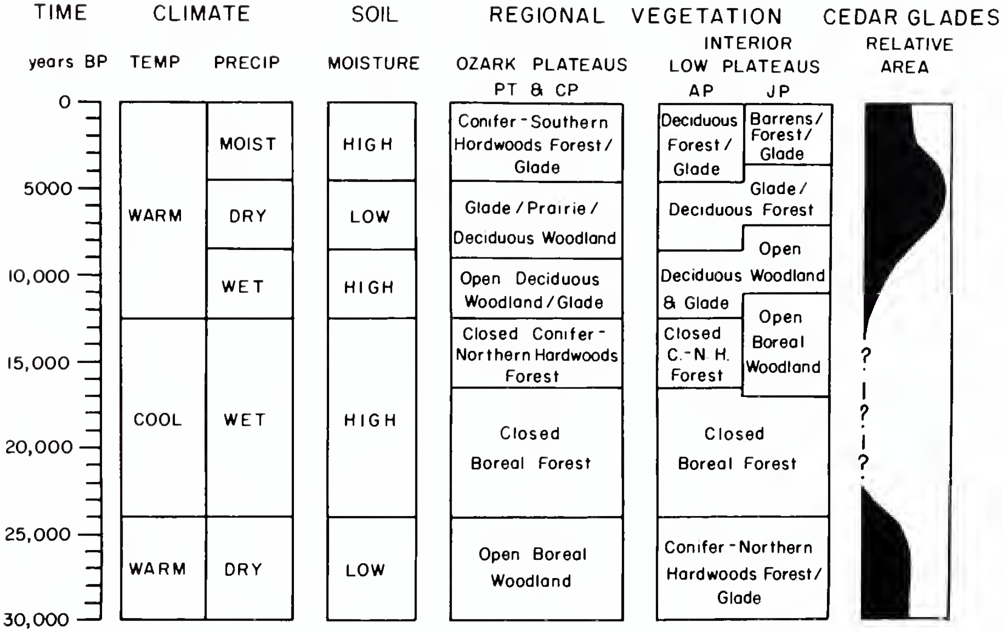

Fig. 2. Environmental and vegetational history of the cedar glades region. Letter codes for site names follow Fig. 1.

to as recently as 2000 years BP. Organic-rich clays dating from more than 40,000 years BP to about 23,000 years BP contained a fossil-pollen assemblage dominated by non-arboreal pollen (NAP; nomenclature for designating pollen types generally follows McAndrews *et al.* 1973) and pine (*Pinus*; cone scales of jack pine, *Pinus banksiana* Lamb., were also found). Together, *Pinus* and sedge (Cyperaceae) typically comprised 60% of the assemblage, with the remainder consisting of birch (*Betula*), oak (*Quercus*), willow (*Salix*), grass (Gramineae), ragweed (*Ambrosia* type), sage (*Artemisia*), and other members of the family Compositae (King 1973). Between 23,000 years BP and about 16,000 years BP, the fossil-pollen assemblages in the spring deposits were dominated by grains of arboreal pollen (AP), with up to 90% spruce (*Picea*) and only minor amounts of pine and sedge. From 16,000 years BP to the end of the fossil-pollen record at about 14,000 years BP, representation of temperate deciduous trees increased at the Pomme de Terre River sites. As exemplified at Boney Springs, this transitional assemblage included oaks, willow, alder (*Alnus*), ash (*Fraxinus*), elm (*Ulmus*), hazel (*Corylus*), and hornbeam (*Ostrya/Carpinus*).

The pine-NAP assemblage dated from 40,000 years BP to 23,000 years BP was interpreted to represent an open jack pine woodland (Fig. 2) during a time of relatively warm, interstadial climatic conditions that immediately preceded the onset of the last, or Late Wisconsinan, glacial maximum (King 1973). King inferred that the shift at 23,000 years BP to a fossil-pollen assemblage dominated by spruce reflected development of a closed boreal forest in response to cooler and wetter climatic conditions during full-glacial times. Based upon these studies, King (1973) concluded that the oak-hickory forests today characteristic of the Ozarks are no older than the Holocene (the last 12,500 years). He further speculated that the occurrences of both endemic species and disjunct plant populations found there today may have been introduced since the transition from Pleiostocene to Holocene environmental conditions.

Cupola Pond, Southeastern Missouri

The stream terrace deposits investigated by King along the Pomme de Terre River contain critical gaps in time, with no direct plant-fossil evidence of vegetational change for the key time interval spanning the late-glacial transition from the Pleistocene to the present-day interglacial climatic conditions of the Holocene. We have recently studied (Smith 1984) a 12-meter sediment core from Cupola Pond, Ripley County, Missouri (Fig. 1). This site has yielded the first continuous pollen and plant-macrofossil sequence available for the full-glacial, late-glacial, and postglacial time intervals in the southeastern Ozark Plateaus.

The paleoecologic record from Cupola Pond spans the past 17,000 years, based on 10 radiocarbon dates. At Cupola Pond, full-glacial pollen assemblages were co-dominated by spruce and jack pine, with little representation of either deciduous trees or herbs. Beginning about 15,500 years BP, deciduous trees including black ash (*Fraxinus nigra-quadrangulata* type) and oak increased markedly in abundance in the pollen record, and from 12,500 years BP to about 9000 years BP, oak, hickory (*Carya*), and hornbeam were dominant. After 9000 years BP, oak was the major arboreal pollen type, until after 4000 years BP, when southern shortleaf pine (*Pinus echinata* Mill.) and tupelogum (*Nyssa aquatica* L.) spread into the southeastern Ozarks and became represented in the pollen sequence.

From 12,500 to about 4000 years BP, pollen of herbs became significant in the Cupola Pond record. Ragweed pollen became particularly abundant in sediments containing the oak-hickory-hornbeam assemblage between 12,500 and 9000 years BP. Grasses became important in the mid-Holocene interval between 9000 and 4000 years BP, then diminished again during the late Holocene after 4000 years BP.

The paleoecologic record from Cupola Pond is interpreted (Fig. 2) to reflect (1) closed, mixed boreal forest of jack pine and spruce during cool, wet climatic conditions of the full-glacial interval; (2) development of a mixed conifer-northern hardwoods forest from 15,500 years BP to 12,500 years BP, with the northward invasion of temperate deciduous trees in response to late-glacial climatic warming; (3) an early-Holocene interval, between 12,500 and 9000 years BP, of warm climate with relatively high seasonal contrast that favored development of open deciduous woodland; (4) the fragmentation of mixed deciduous woodland to form oak savanna during the mid-Holocene interval from 9000 to 4000 years BP, reflecting increased summer temperatures, accentuated drought frequency and severity, and increased fire frequency during the peak interglacial (Hypsithermal interval); and (5) northward spread of warm-temperate tree species such as shortleaf pine and tupelogum during the late Holocene.

VEGETATIONAL AND CLIMATIC HISTORY OF THE INTERIOR LOW PLATEAUS

Nonconnah Creek, Tennessee

Some of the oldest radiocarbon-dated evidence for vegetational changes east of the Mississippi River is from Nonconnah Creek, Shelby County, southwestern Tennessee (Fig. 1). Nonconnah Creek is situated in the northern portion of the Mississippi Embayment physiographic region, between the Ozarks and the Interior Low Plateaus. Stream-terrace sediments along Nonconnah Creek are dated from more than 33,000 years BP to about 13,000 years BP (Delcourt *et al.* 1980).

Between 30,000 years BP and 24,000 years BP, the arboreal pollen sum was dominated by oak and pine, with ash, birch, and cedar (*Juniperus* type). In addition, numerous shrubs and herbs were represented, including leadplant (*Amorpha*), ephedra (*Ephedra*), prairie-clover (*Petalostemon* (Wemple 1970) or *Dalea*), gaura (*Gaura*), Indian hemp (*Apocynum*), pinks (Caryophyllaceae), mustards (Cruciferae), sedges, grasses, ragweed, and sage.

Full-glacial pollen spectra were dominated by spruce, but with consistent representation in both the pollen and plant-macrofossil records of temperate deciduous trees including beech (*Fagus grandifolia* Ehrh.), tuliptree (*Liriodendron tulipifera* L.), sugar maple (*Acer saccharum* Marsh.), walnut (*Juglans nigra* L.), hazel, oaks, and hickories. Deciduous forest taxa persisted throughout the full-glacial and late-glacial intervals in the Nonconnah Creek record.

The fossil-pollen assemblage dated between 30,000 years BP and 24,000 years BP indicates that prairie and glades species were widespread during interstadial times and occupied disturbed habitats even along streams in West Tennessee such as Nonconnah Creek. With the onset of glaciation in the north, after 24,000 years BP temperate vegetation in the northern Mississippi Embayment was displaced in part by boreal taxa including spruce and tamarack (*Larix laricina* (Du Roi) K. Koch). However, the severity of full-glacial conditions was apparently ameliorated at least locally along the loessial soils of the Blufflands adjacent the Mississippi River Alluvial Valley allowing for co-existence of boreal and cool-temperate deciduous forest species (Delcourt and Delcourt 1975; Delcourt and Delcourt 1977; Delcourt *et al.* 1980).

Anderson Pond, Tennessee

Anderson Pond, White County, Tennessee, is situated on the eastern Highland Rim about 370 km east of Nonconnah Creek (Fig. 1). Sediments from Anderson Pond provide a continuous record of vegetation and climate change over the past 19,000 years for the southern portion of the Interior Low Plateaus region (H. Delcourt 1979).

At Anderson Pond, full-glacial sediments contained a fossil-pollen assemblage dominated by up to about 80% jack pine, with lesser amounts of spruce, and only trace percentages of pollen of deciduous tree taxa and herbs. By 16,500 years BP, deciduous trees began to increase in representation in the pollen record as percentages of pine and spruce declined, and after 12,500 years BP the pollen spectra were dominated by oaks, with hornbeam, beech, sugar maple, and other cool-temperate deciduous trees. After 9000 years BP, warm-temperate tree taxa such as black gum (*Nyssa sylvatica* Marsh.), chestnut (*Castanea dentata* (Marsh.) Borkh.), hickories, and red maple (*Acer rubrum* L.) became substantial contributors to the plant-fossil sequence. Between 8500 and 4500 years BP, pollen percentages of mesic, deciduous trees diminished, and oaks and ash dominated the record. After 4500 years BP, mesic, deciduous trees again appeared in the pollen spectra. Throughout the fossil-pollen record from Anderson Pond, pollen of NAP were less than 15% of the total sum of upland pollen grains and spores (H. Delcourt 1979).

The pollen record from Anderson Pond indicates that the landscape of the eastern Highland Rim was continuously forested from full-glacial times to the present. The full-glacial vegetation surrounding Anderson Pond was closed jack pine forest, with spruce locally important on the watershed. Full-glacial climates were more severe in Middle Tennessee than on the loess bluffs at Nonconnah Creek, and the apparent decrease in available precipitation reflected in the predominance of jack pine was possibly accentuated by poorer soils of the Highland Rim.

Late-glacial climatic amelioration that began with the first major retreat of the Laurentide Ice Sheet at about 16,500 years BP (Dreimanis 1977; Delcourt and Delcourt 1984) was reflected in the rapid decline in abundance of xeric boreal conifers and subsequent invasion of cool-temperate deciduous trees after 16,500 years BP (Delcourt and Delcourt 1985b). During the late-glacial and early-Holocene intervals, forest composition continued to change and mesic, deciduous forest became established in the region. During the mid-Holocene interval, forests became more xeric, reflecting the trend toward warmer and drier climatic conditions. Late-Holocene forests contained more mesic taxa.

Jackson Pond, Kentucky

Jackson Pond, Larue County, Kentucky, is located in the northern portion of the Interior Low Plateaus and within 190 km of the full-glacial ice margin (Fig. 1). Jackson Pond is located along the Dripping Springs escarpment, which is the local water-recharge area for springs that keep the groundwater table relatively high. The site is also at the juncture of predominantly deciduous forest and major outlying areas of grassland, the Kentucky "Barrens" (Dicken 1935; Baskin and Baskin 1981).

Jackson Pond sediments have been radiocarbon-dated from about 20,000 years BP to the present (Wilkins 1985). Full-glacial sediments dated from 20,000 years BP to about 17,000 years BP contained an arboreal pollen assemblage with about 70% spruce and up to 30% pine. Sedge and grass pollen comprised less than 5% of the total pollen sum during the full-glacial interval. After 17,000 years BP, spruce diminished to generally 50% of the arboreal pollen as pine increased to about 50%. Pollen percentages of deciduous trees remained very low, generally occurring only in trace amounts. However, during the late-glacial period, which lasted from about 17,000 years BP to 11,500 years BP, representation of sedges increased to as much as 25% of the total upland pollen. The transition from late-glacial to Holocene conditions at 11,500 years BP, was marked by prominent declines in the percentages of boreal conifers, followed by major increases in deciduous tree pollen including that of oaks, black ash, hornbeam, hickories, elm, and willow. Oaks and hornbeam together comprised as much as 80% of the arboreal pollen from 10,000 years BP to about 7500 years BP. During the mid-Holocene interval, from 7500 years BP to about 3500 years BP, oaks, ash, hickories, willow, sweetgum (*Liquidambar styraciflua* L.), black gum, and chestnut were the important trees growing in the vicinity of Jackson Pond. After 3500 years BP, willow decreased in importance locally, and grass rose to as much as 20% of the total upland pollen sum. Prairie indicators such as *Petalostemon* occurred throughout the last 3500 years of the late-Holocene interval (Wilkins 1985).

The pollen record from Jackson Pond indicates that closed boreal forest dominated by spruce, with jack pine as a subdominant, occupied central Kentucky from 20,000 years BP to 17,000 years BP. After 17,000 years BP, the forest thinned to an open boreal woodland that persisted until 11,500 years BP, when it was replaced by an open deciduous woodland that persisted through the mid-Holocene interval. The increase in grass pollen at Jackson Pond did not occur until *after* the time of the classic "Prairie Peninsula" period, the extension of prairie eastward at the expense of forest elsewhere in the Midwest region (Webb *et al.* 1983). The pollen record from Jackson Pond indicates that the "Big Barrens" of Kentucky are not the result of mid-Holocene warming and drying, but, rather that they represent a more recent change in vegetation. At the time of EuroAmerican settlement, these large "Barren" grasslands were observed to be maintained at least in part by burning activities of Native American Indians (Wilkins 1985).

Paleohydrology and Paleoclimate

High rates of sediment accumulation occurred at Anderson, Jackson, and Cupola ponds throughout the full-glacial and late-glacial intervals, in contrast with their much slower, although uniform, rates of sedimentation in the postglacial interval (H. Delcourt 1979; Smith 1984; P. Delcourt 1985; Wilkins 1985). From 20,000 years BP to generally 12,500 years BP, relatively high water levels in the ponds and accelerated sheetwash erosion of both organic and inorganic materials from slopes surrounding the sinkholes indicate that upland soils were more constantly water-saturated during the full-glacial and late-glacial intervals than they were during either the interstadial preceding the last full-glacial interval (30,000 years BP to 24,000 years BP) or the Holocene interglacial period (12,500 years BP to the present).

Higher water tables during the full-glacial and late-glacial intervals are consistent with the evidence that climatic conditions were colder than at present, but were equable in seasonal contrast. The presence of the Laurentide Ice Sheet in northern North America (Fig. 1) posed an orographic barrier several kilometers high that blocked incursions of the Arctic Airmass into eastern North America, preventing the occurrence of extemely cold conditions in the Southeast during the full-glacial interval (Delcourt and Delcourt 1984).

IMPLICATIONS FOR THE CEDAR GLADES

Late-Quaternary changes in climate, soil moisture (relative position of groundwater table), and regional vegetation have implications for the distributional history of cedar glades endemics as well as for changes in the areal extent of cedar glades vegetation through time (Fig. 2).

The fossil-pollen evidence from sites in Missouri, Kentucky, and Tennessee indicates that climatic conditions were favorable for establishment of cedar glades vegetation on edaphically suitable sites during warm interstadial intervals of the Pleistocene as well as during the Holocene interglacial interval. During full-glacial and late-glacial intervals, between 24,000 years BP and 12,500 years BP, colder climates and high groundwater tables may have eliminated suitable habitats for the cedar glades flora north of 34 degrees N latitude.

If the cedar glades flora were displaced from Kentucky and Tennessee during the full-glacial interval, suitable habitats on carbonate exposures may have existed in northern Alabama in the southernmost portion of the Interior Low Plateaus region. From full-glacial refuges in Alabama, plant species characteristic of cedar glades may have colonized more-northern sites during the Holocene, just as temperate deciduous trees also spread northward with climatic warming. Postglacial expansion from refuges in northern Alabama and invasion of suitable, although patchy, sites northward in Middle Tennessee and central Kentucky is consistent with the speculations of Rollins (1963) concerning the area of origin of the present-day species of *Leavenworthia,* although our interpretation of the distributional history of this genus suggests that many of the endemic species may be postglacial in their time of speciation. An alternative hypothesis is that small outcrops of Ordovician and Mississippian limestone in Tennessee and Kentucky might have had winter-wet, summer-dry microclimates even during the full-glacial interval. In this case, certain of the endemics that today colonize the cedar glades may have persisted in geograhically restricted, suitable sites, even though the regional vegetation changed dramatically in composition.

During the mid-Holocene interval, from about 8500 years BP to 4500 years BP, warm, dry regional climates may have resulted in more severe summer droughts, lowered groundwater tables, and more xeric soils. These climatic, hydrologic, and edaphic conditions may have exceeded tolerances of mesic trees and resulted in their dieback in "marginal areas" of thin soils or exposed bedrock. Expansion of openings within the forest would increase the area potentially occupied by cedar glades communities. A mid-Holocene increase in both the number and areal extent of cedar glades (Fig. 2) would have allowed for increased genetic interchange among plant populations distributed between the Ozarks and the Interior Low Plateaus.

Over the last several thousand years, a climatic trend toward more mesic conditions (Delcourt and Delcourt 1984) has favored closed deciduous forest in the southeastern portion of the Prairie Peninsula region. However, the late-Holocene interval coincided with the time of major expansion in population size of Native Americans throughout the major river valleys of unglaciated southeastern North America (Smith 1978). Forest openings including cedar glades may have been perpetuated by Native Americans through forest clearance for cultivation (Delcourt *et al.* 1986). Indian activities included deliberate burning of upland forests to improve hunting; Indian burning may have contributed to an increase in the number of forest openings and exposure of bare rock in areas of shallow soils, as well as the expansion of grasslands, as shown by late-Holocene expansion of the "Big Barrens" of central Kentucky (Wilkins 1985).

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DISTRIBUTION AND GEOGRAPHICAL/EVOLUTIONARY RELATIONSHIPS OF CEDAR GLADE ENDEMICS IN SOUTHEASTERN UNITED STATES

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ABSTRACT

The cedar glade flora of the Southeast includes 29 taxa endemic or nearly-endemic to cedar glades; 10 of these are in the genus *Leavenworthia*. Twenty-two are restricted to glades in the Southeast, two occur in the Southeast and in adjacent southern Indiana, two occur in the Southeast with extant populations north of the glacial boundary in Illinois, two have their centers of distribution in the Ozarks with disjunct populations in Middle Tennessee, and one is found in cedar glades of the Southeast, Ozarks, and southern Indiana and Ohio. Some of the endemics have their closest relatives west of the Mississippi River, while others are closely allied to eastern taxa. We suggest that the western taxa, or their ancestors, may have entered the Southeast from the Southwest and/or the Ozark Plateau, and later *Astragalus tennesseensis* and *Dalea foliosa* migrated from the Central Basin of Tennessee to the glaciated Midwest. The high degree of endemism in the southeastern cedar glades and the presence of taxa with and without close relatives suggest that the glades have served as sites of plant speciation for a long period of time.

INTRODUCTION

In the unglaciated eastern United States (*i.e.* east of the 98th meridian and south of the glacial boundary, *sensu* Braun 1955), "cedar glade" is the term used to describe natural treeless areas characterized by limestone or dolomite bedrock at or near the surface (Steyermark 1940; Quarterman 1950). These areas also are sometimes referred to as limestone glades or dolomite glades (Kurz 1981; Nelson and Ladd 1983). The plant communities are dominated by herbaceous species, but theoretically, a deciduous forest will develop on these sites, if given enough time (Quarterman 1950). In the southeastern United States (Fig. 1), a high percentage of the cedar glades occur within the Interior Low Plateaus Physiographic Province in Kentucky, Middle Tennessee and northern Alabama (Baskin *et al.* 1968; C. Baskin and J. Baskin 1975; Baskin and Baskin 1978, 1985a). The only other physiographic province with a significant number of cedar glades is the Ridge and Valley. Within this province, cedar glades occur in Alabama, Georgia, Tennessee (Rollins 1963; Baskin *et al.* 1968; Finn 1968), Virginia (Carr 1944) and West Virginia (Bartgis 1985). South of the glacial boundary, in the eastern United States, glades or glade-like areas also occur in southern Ohio (Braun 1928), southern Indiana (Aldrich *et al.* 1982; Bacone *et al.* 1983), southern Illinois (Kurz 1981), the Ozark Region of Missouri (Steyermark 1959; Nelson and Ladd 1983) and Arkansas (Keeland 1978), southeastern Oklahoma (Rollins 1963) and eastern Texas (Rollins 1963; Nixon *et al.* 1983).

The flora of the southeastern cedar glades consists of over 400 taxa of vascular plants (Baskin and Baskin 1985b) including endemics, species characteristic of cedar glades but also geographically widely distributed in prairies, barrens and other open habitats, and native and introduced weeds. In this paper, a cedar glade endemic is defined as a plant taxon that is (or was prior to European settlement)

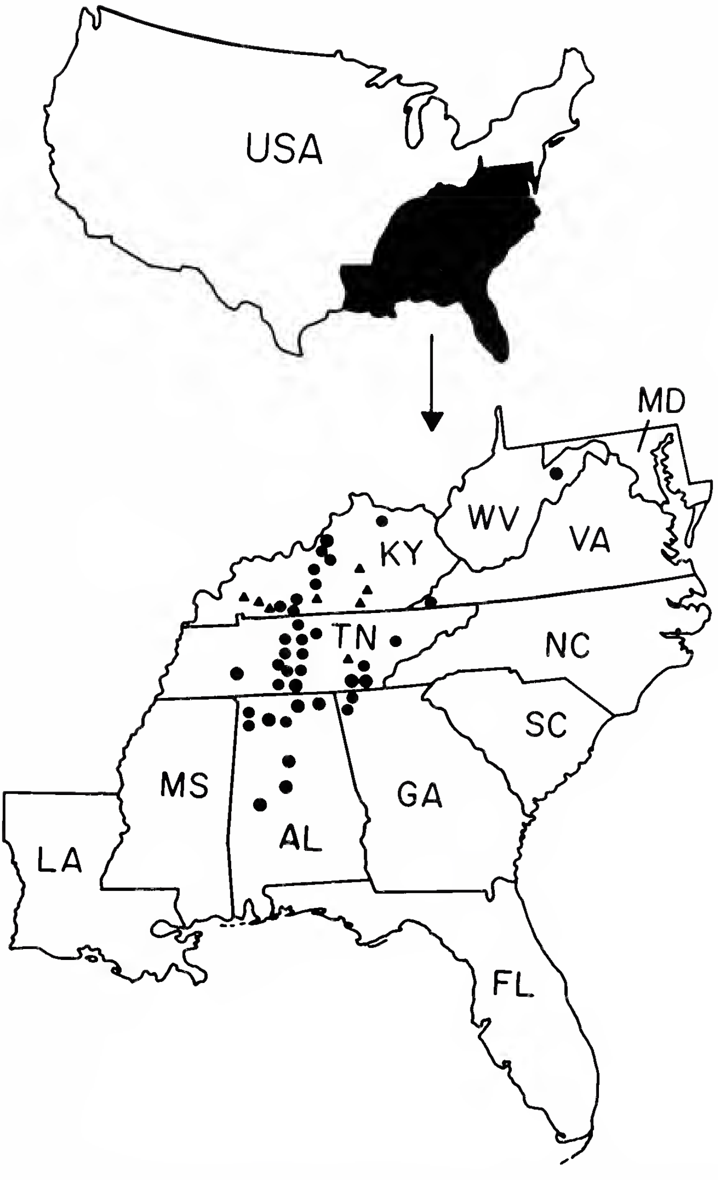

Fig. 1. County distribution map of cedar glades (dots) and cedar glade-like areas (triangles) in southeastern United States. The triangles are based on the occurrence of *Leavenworthia uniflora* at the site. (Modified from Baskin and Baskin 1985b.)

restricted or almost restricted to cedar glades and glade-like areas. Although the endemics are only a minor component of the cedar glade flora in number of species, they are its most distinctive element. Our list of cedar glade endemics that occur in the southeastern United States includes 29 taxa (Table 1), which is 9 to 10% of the native cedar glade flora. The 29 taxa of cedar glade endemics include 22 that are restricted to the Southeast and seven that also occur on glades outside the Southeast. The purposes of this paper are to give the distribution of each endemic by state and county and to discuss their geographical/evolutionary relationships.

Table 1. Cedar glade endemics in southeastern United States.

- Endemic to southeast
  - *Dalea gattingeri* (Heller) Barneby
  - *Delphinium alabamicum* Kral
  - *Echinacea tennesseensis* (Beadle) Small
  - *Leavenworthia alabamica* Rollins var. *alabamica*
  - *L. alabamica* Rollins var. *brachystyla* Rollins
  - *L. crassa* Rollins var. *crassa*
  - *L. crassa* Rollins var. *elongata* Rollins
  - *L. exigua* Rollins var. *exigua*
  - *L. exigua* Rollins var. *laciniata* Rollins
  - *L. exigua* Rollins var. *lutea* Rollins
  - *L. stylosa* Gray
  - *L. torulosa* Gray
  - *Lesquerella lyrata* Rollins
  - *Lobelia appendiculata* A. DeCandolle var. *gattingeri* (Gray) McVaugh
  - *Onosmodium molle* Michaux subsp. *molle*
  - *Orbexilum stipulatum* (Torrey & Gray) Rydberg
  - *Oxalis priceae* Small subsp. *priceae*
  - *Pediomelum subacaule* (Torrey & Gray) Rydberg
  - *Penstemon tenuiflorus* Pennell
  - *Phacelia dubia* (Linnaeus) Trelease var. *interior* Fernald
  - *Solidago shortii* Torrey & Gray
  - *Talinum calcaricum* Ware
- Southeast and southern Indiana
  - *Hypericum dolabrifrome* Ventenat
  - *Viola egglestonii* Brainerd
- Disjunct to Midwest
  - *Astragalus tennesseensis* Gray
  - *Dalea foliosa* (Gray) Barneby
- Disjunct from Ozarks
  - *Onosmodium molle* Michaux subsp. *subsetosum* (Mackenzie & Bush) Cochrane
  - *Solidago gattingeri* Chapman
- Southeast, Ozarks and southern Indiana and Ohio
  - *Leavenworthia uniflora* (Michaux) Britton

Most of the cedar glade endemics have some weedy tendencies, and thus they also now occur in glades and glade-like areas that exhibit various degrees of disturbance. Where glades are adjacent to rocky roadsides, pastures and powerline rights-of-way, it is not uncommon to find endemics growing in these man-made habitats. The tendency for all taxa in the genus *Leavenworthia* to behave locally as weeds is well documented (Lloyd 1965; Mahler 1981; Rollins 1952, 1981; Cranfill et al. 1985). In addition to growing in rocky pastures and along scraped roadsides, *Leavenworthia alabamica* and *L. crassa* have invaded plowed fields adjacent to glades in northern Alabama. None of the cedar glade endemics, however, seems to have spread very far from its original glade habitat. Thus, their geographical ranges are probably very similar to what they were in pre-settlement times.

GEOGRAPHICAL DISTRIBUTION

Taxa Endemic to Southeast

Dalea gattingeri. ALABAMA: Bibb, Franklin, Hale, and Lawrence; GEORGIA: Catoosa and Walker; TENNESSEE: Bedford, Cannon, Davidson, Hamilton, Marshall, Maury, Meigs, Rutherford, Williamson, and Wilson (Breeden 1968; Wemple 1970; Baskin and Baskin 1984a). The specimen from Hale County, Alabama, was collected by Mohr (1901) from "bald prairies," which were cedar glade-like areas on Cretaceous limestone in the Black Belt Region of Alabama. Specimens from Bibb and Hale counties, Alabama, were collected in the 1890's, and the species probably has been extirpated from this part of its range (Baskin and Baskin 1984a).

Delphinium alabamicum. ALABAMA: Franklin, Hale, and Perry; GEORGIA: Polk (Kral 1976; Warnock 1982). Extant populations of this recently described species (Kral 1976) are now known to occur only in Franklin County, Alabama (Warnock 1982). Warnock states that the specimen from Polk County, Georgia, is possibly from a garden transplant. As with *Dalea gattingeri,* the historical distribution of *D. alabamicum* included the Black Belt Region of Alabama (Kral 1976), presumably in cedar glade-like areas.

Echinacea tennesseensis. TENNESSEE: Davidson, Rutherford, and Wilson (Somers 1983). McGregor (1968), the most recent monographer of the genus, thought that *E. tennesseensis* was possibly extinct. However, since McGregor's study, a few populations of this species have been found in Davidson, Rutherford, and Wilson counties in the Central Basin of Tennessee. *Echinacea tennesseensis* is listed as endangered by the U.S. Fish and Wildlife Service (Smith 1985).

Leavenworthia alabamica var. *alabamica.* ALABAMA: Colbert, Franklin, and Lawrence (Rollins 1963).

Leavenworthia alabamica var. *brachystyla.* ALABAMA: Morgan (Rollins 1963).

Leavenworthia crassa var. *crassa.* ALABAMA: Lawrence and Morgan (Rollins 1963).

Leavenworthia crassa var. *elongata.* ALABAMA: Morgan (Rollins 1963).

Leavenworthia exigua var. *exigua.* GEORGIA: Catoosa and Walker; TENNESSEE: Bedford, Davidson, Decatur, Marshall, Maury, Rutherford, Williamson, and Wilson (Rollins 1963).

Leavenworthia exigua var. *laciniata.* KENTUCKY: Bullitt and Jefferson (Cranfill *et al.* 1985).

Leavenworthia exigua var. *lutea.* ALABAMA: Jefferson and St. Clair. TENNESSEE: Maury (Rollins 1963; Baskin and Baskin 1973a; Kral 1983).

Leavenworthia stylosa. TENNESSEE: Bedford, Davidson, Maury, Rutherford, Smith, and Wilson (Rollins 1963).

Leavenworthia torulosa. ALABAMA: Madison; KENTUCKY: Logan, Simpson, and Warren; TENNESSEE: Bedford, Bradley, Davidson, Giles, Lincoln, Marshall, Maury, Rutherford, Sumner, Williamson, and Wilson (Rollins 1963; Baskin and Baskin 1984a; Cranfill *et al.* 1985). The only known specimen of *L. torulosa* from Alabama (at ALU) was collected by Charles Mohr in 1880, and the species probably has been extirpated from this state (Baskin and Baskin 1984a).

Lesquerella lyrata. ALABAMA: Colbert and Franklin (Rollins and Shaw 1973, Webb and Kral 1986).

Lobelia appendiculata var. *gattingeri.* KENTUCKY: Warren; TENNESSEE: Bedford, Davidson, Marshall, Maury, Rutherford, Williamson, and Wilson (Baskin and Baskin 1979). This taxon was collected in Kentucky in 1985 for the first time, by Marc Evans of the Kentucky Nature Preserves Commission. Mohr (1901) lists the species in his *Flora of Alabama* from Montgomery County, and there is a Mohr specimen labelled *Lobelia gattingeri* at ALU that was collected in this county in 1880. Rogers McVaugh examined this specimen in 1979 and annotated it as "*Lobelia appendiculata* A. DC. nearer to var. *appendiculata* than to var. *gattingeri*."

Onosmodium molle subsp. *molle*. ALABAMA: Franklin; ILLINOIS: Jackson; KENTUCKY: Logan; TENNESSEE: Carroll, Davidson, Giles, Maury, Rutherford, Sumner, Trousdale, Williamson, and Wilson (Baskin *et al.* 1983). This taxon apparently has been extirpated from the one site (Grand Tower, Jackson County) where it was collected in southern Illinois. The most recent collection seen was made in 1901 by H. A. Gleason (at GH).

Orbexilum stipulatum (=*Psoralea stipulata* T. & G.). KENTUCKY: Jefferson (Baskin *et al.* in press b). Although this species is still reported from Indiana (Crovello *et al.* 1983), all specimens in existence seem to have been collected on Rock Island of the Falls of the Ohio River at Louisville in Jefferson County, Kentucky. The species is included as a cedar glade endemic because (1) Rock Island was mostly bare limestone and (2) the plants listed by C. W. Short in letters to John Torrey as growing on the Island include several that typically grow in cedar glades and glade-like areas. The Island was destroyed in the 1920's in preparation for construction of McAlpine Dam and the Louisville Hydroelectric Plant. The small parts of the Island that still exist very much resemble cedar glades. *Orbexilum stipulatum* has not been collected in over 100 years and thus is believed to be extinct.

Oxalis priceae subsp. *priceae*. Eiten (1963) gives its distribution as, "Southeastern U.S.A.: central Kentucky, central Tennessee, northeast Mississippi, Alabama and Georgia, apparently restricted to dry limestone areas." Mulcahy (1964) states, "Subspecies *priceae* is limited to a large extent to limestone outcrops of middle Tennessee and northern Alabama." He cites populations in Lawrence and Franklin counties, Alabama, and Rutherford and Wilson counties, Tennessee. The only Kentucky specimens that we have seen of *O. priceae* subsp. *priceae* (at MO) were collected by Sadie Price in 1898 and 1899. Price may have made the last collection of *O. priceae* subsp. *priceae* in Kentucky, where the taxon is believed to be extirpated. Duncan and Kartesz (1981) report *O. priceae* subsp. *priceae* from the piedmont and coastal plain of Georgia. In our opinion, however, the two Georgia specimens of *O. priceae* (at GA) belong to the subsp. *colorea* (Small) Eiten. *Oxalis priceae* subsp. *priceae* has not been found in the cedar glades of northwest Georgia.

Pediomelum subacaule (=*Psoralea subacaulis* T. & G.). ALABAMA: Colbert and Franklin; GEORGIA: Catoosa; TENNESSEE: Bedford, Davidson, Marshall, Maury, Rutherford, Williamson, and Wilson (Baskin and Quarterman 1970).

Penstemon tenuiflorus. Pennell (1935) reports its occurrence in: ALABAMA: Cullman, Jefferson, Lauderdale, Morgan, and Walker; KENTUCKY: Christian, Edmonson, Lyon, Muhlenberg, Ohio, and Warren; MISSISSIPPI: Tishomingo; TENNESSEE: Cheatham, Chester, Davidson, Decatur, Henderson, Robertson, Rutherford, and Wilson. Koelling (1964) gives its distribution as western Kentucky to northern Alabama and does not add any additional counties to Pennell's list.

Phacelia dubia var. *interior*. Fernald (1944) described variety *interior* and gives its distribution as Alleghany County, Virginia, and northcentral Tennessee. In his revision of *Phacelia* subgenus *Cosmanthus*, however, Constance (1949) did not recognize this variety. Instead, he considered *P. dubia* to consist of the typical variety and the granite outcrop endemic, var. *georgiana* McVaugh. More recent studies (Murdy 1966; Putman 1967) have upheld the morphological distinctness of the middle Tennessee plants as var. *interior*. According to Putman (1967), var. *interior* is restricted to the cedar glades of middle Tennessee and occurs in Davidson, Marshall, Rutherford, and Wilson counties.

Solidago shortii. KENTUCKY: Fleming, Jefferson, Nicholas, and Robertson (Braun 1941; Baskin and Baskin 1984b). In Jefferson County, *S. shortii* occurred on Rock Island of the Falls of the Ohio River at Louisville, but it has been extirpated from this site. Most of the specimens from Rock Island were collected by C. W. Short between 1840 and 1860. *Solidago shortii* is listed as endangered by the U.S. Fish and Wildlife Service (Smith 1985).

Talinum calcaricum. ALABAMA: Franklin; TENNESSEE: Davidson, Giles, Marshall, Maury, Rutherford, Sumner, and Wilson (Ware 1967).

Southeast and Southern Indiana

Hypericum dolabriforme. GEORGIA: Catoosa; INDIANA: Crawford and Harrison; KENTUCKY: Barren, Edmonson, Fleming, Franklin, Hardin, Hart, Jefferson, Larue, Lincoln, Logan, Nelson, Nicholas, Pulaski, Robertson, and Wayne; TENNESSEE: Anderson, Bledsoe, Davidson, Knox, Meigs, Monroe, Roane, and Rutherford (Braun 1943; Gillespie 1955; Adams 1962; Aldrich *et al.* 1982; Bacone *et al.* 1983).

The occurrence and distribution of *H. dolabriforme* in Alabama needs further study. Although Harbison (1902) reported it from Marshall and Jackson counties, Adams (1962, 1973) did not include the state within the distribution of the species. Freeman *et al.* (1979) have reported it from Cherokee and Jackson counties, and R. Kral (letter, 24 Oct. 1984) has, ". . . material which in most ways answers to *H. dolabriforme* from Cherokee and Franklin counties in Alabama."

Viola egglestonii. ALABAMA: Franklin; GEORGIA: Catoosa and Walker; INDIANA: Harrison; KENTUCKY: Bullitt, Hardin, Jefferson, and Nelson; TENNESSEE: Bedford, Cannon, Davidson, Hamilton, Marshall, Maury, Meigs, Rutherford, Smith, Sumner, and Wilson (Baskin *et al.* in press a).

Disjunct to Midwest

Astragalus tennesseensis. ALABAMA: Franklin and Morgan; ILLINOIS: Ogle, LaSalle, Grundy, Lee, Tazewell, and Will; INDIANA: Tippecanoe; TENNESSEE: Bedford, Davidson, Marshall, Maury, Robertson, Rutherford, Williamson, and Wilson (Gambill 1953; C. Baskin *et al.* 1972).

Mohr (1901) reported *A. tennesseensis* from Lauderdale County, Alabama, but the only specimen of this species at ALU was collected by Charles Mohr (without date) near Russelville which is in Franklin County. *Astragalus tennesseensis* is believed to be extirpated in Indiana (Bacone and Hedge 1980) and presently is known to be extant at only one locality, in Tazewell County, in Illinois (McFall 1984).

Dalea foliosa. ALABAMA: Franklin and Morgan; ILLINOIS: Boone, LaSalle, Kankakee, Kane, Ogle, and Will; TENNESSEE: Davidson, Franklin, Marshall, Maury, Rutherford, Williamson, and Wilson (Baskin and Baskin 1973b; Swink and Wilhelm 1979; Sheviak 1981). The only known extant populations of *D. foliosa* in Illinois occur in thin-soiled dolomite prairies along the Des Plains River in Will County, Illinois (Sheviak 1981).

Disjunct from Ozarks

Onosmodium molle subsp. *subsetosum*. ARKANSAS: Baxter, Benton, Carroll, Fulton, Garland, Hot Springs, Independence, Izard, Newton, Sharp, St. Francis, Stone, Washington, and Yell; MISSOURI: Barry, Boone, Camden, Christian, Cooper, Dent, Douglas, Greene, Jasper, Jefferson, Iron, Lawrence, McDonald, Miller, Montgomery, Morgan, Newton, Oregon, Osage, Ozark, Pettis, Phelps, Ralls, Shannon, St. Clair, St. Francois, St. Louis, Ste. Genevieve, Stone, Texas, Washington, and Wright; OKLAHOMA: Adair and McCurtain; TENNESSEE: Franklin and Rutherford (Steyermark 1963; Das 1965; Smith 1978; Patrick *et al.* 1983).

Solidago gattingeri. MISSOURI: Barry, Benton, Camden, Cedar, Christian, Dallas, Franklin, Hickory, Jefferson, Laclede, McDonald, Morgan, Oregon, Ozark, Polk, Pulaski, Ripley, St. Clair, St. Francois, St. Louis, Stone, Taney, Washington, and Wright; TENNESSEE: Rutherford (Svenson 1941; Steyermark 1963; Morton 1972).

Southeast, Ozarks and Southern Indiana and Ohio

Leavenworthia uniflora. ALABAMA: Jackson, Lawrence, Madison, and Morgan; ARKANSAS: Baxter, Carroll, Marion, Randolph, and Sharp; GEORGIA: Catoosa and Walker; INDIANA: Clark; KENTUCKY: Barren, Caldwell, Christian, Crittenden, Hardin, Lincoln, Logan, Oldham, Pulaski, Shelby, Simpson, Todd, Warren, and Wayne; MISSOURI: Barry, Camden, Christian, Crawford, Dallas, Douglas, Franklin, Gasconade, Hickory, Iron, Jefferson, Laclede, Madison, Maries, McDonald, Miller, Moniteau, Montgomery, Morgan, Ozark, Perry, Phelps, Polk, Pulaski, Reynolds, Shannon, St. Francois, St. Louis, Stone, Taney, Washington, Webster, and Wright; OHIO: Adams, Highlands, Pike, and Scioto; TENNESSEE: Bledsoe, Bedford, Cannon, Davidson, Hamilton, Knox, Lincoln, Marshall, Maury, Rutherford, Sumner, and Wilson (Rollins 1963; Steyermark 1963; Smith 1978; Cranfill *et al.* 1985). Many of the sites for this species in Kentucky are small glade-like areas (limestone outcrops) in pastures.

GEOGRAPHICAL/EVOLUTIONARY RELATIONSHIPS

The 11 taxa (7 species and 4 varieties) in the genus *Leavenworthia* are all endemic to cedar glades in the unglaciated portion of the eastern United States. Nine of these taxa are endemic to the Southeast, and *L. aurea* Torr. is endemic to eastern Texas and southeastern Oklahoma. The most widespread taxon is *L. uniflora,* which occurs on glades and glade-like areas in the Southeast, the Ozarks, southern Indiana and southern Ohio. Within the genus there are three chromosome groups. In the diploids, $n = 11$ (*L. crassa, L. alabamica* and *L. exigua*) or 15 (*L. stylosa, L. torulosa* and *L. uniflora*), and in the polyploid *L. aurea*, $n = 24$ (Rollins 1963). According to Rollins (1963), *Leavenworthia* is not closely related to any other American genus of the Cruciferae. He thinks, as did Torrey (1837), that perhaps the genus is more closely related to *Selenia* of the Ozark Region and southwestern United States and adjacent Mexico (Martin 1940) than to any other genus.

Rollins (1963) postulated that the area of origin of the genus *Leavenworthia* was northern Alabama and that the basic species is *L. crassa.* From *L. crassa,* the other species in the genus evolved along two lines. One line gave rise to *L. alabamica* and *L. exigua.* In turn, *L. aurea* evolved from *L. exigua* var. *lutea* and migrated westward. In the second evolutionary line, *L. stylosa,* or an *L. stylosa* type, evolved from the $n = 11$ stock, probably *L. crassa,* in the Central Basin of Tennessee. Thus, the basic species in the $n = 15$ group is *L. stylosa,* and speciation proceeded in a direct line from *L. stylosa* to *L. torulosa* to *L. uniflora,* or else from *L. stylosa* to a common ancestor which gave rise to *L. torulosa* and *L. uniflora.*

Lloyd (1965), however, presents a different hypothesis on the geographical origin of *Leavenworthia.* He speculates that *Leavenworthia* migrated from the Interior Highlands (Ozarks) to the Southeast *via* the Paleozoic land "bridge" (across southern Illinois). Further, the center of distribution for the genus was the Central Basin of Tennessee, and from here the ancestors of *L. alabamica* and *L. crassa* migrated to Alabama. Based on a study of the breeding systems, Lloyd postulates that *L. crassa* recently has evolved from a self-incompatible ancestor of *L. alabamica.* Lloyd accounts for the three distinct chromosome groups in *Leavenworthia* by supposing that they have evolved from forms that are now extinct.

In the most recent taxonomic revision of the genus *Astragalus* in North America, Barneby (1964) concluded that *A. tennesseensis* is morphologically very different from other species of the genus in North America and, therefore, erected section Tennesseensis to accommodate it. The closest relatives of *A. tennesseensis* are *A. sanguineus* Rydb. of the Coahuila Mountains in northeastern Mexico and *A. plattensis* Nutt. of the prairies and plains from Texas to North Dakota (Barneby 1964).

According to Wemple (1970), the affinities of *Dalea foliosa* are with *D. sabinale* (Watson) Shinners, a narrow endemic of the Edwards Plateau of western Texas. However, Barneby (1977) considers *D. foliosa* to be a taxonomically isolated western element in the eastern flora. *Dalea gattingeri* seems to be closely related to *D. tenuifolia* (Gray) Shinners, a species of limestone and granite outcrops and badlands in southwestern Kansas, southeastern Colorado, northeastern New Mexico, and the panhandles of Oklahoma and Texas (Wemple 1970; Barneby 1977). Breeden (1968) did a comparative study of the ecology and morphology of *D. gattingeri* and *D. purpurea* Vent., a species primarily of the prairies and plains of the United States and Canada. He concluded that *D. purpurea* gave rise to *D. gattingeri* in the Central Basin of Tennessee, perhaps after the former migrated from central Illinois during or following the dry Pliocene. The close relationshp between *D. gattingeri, D. purpurea* and *D. tenuifolia* is shown by the fact that they can hybridize (Breeden 1968; Walker 1969; Wemple 1970).

Echinacea tennesseensis is closely related to *E. angustifolia* DC. var. *angustifolia,* a species of dry prairies and barrens from Texas to Canada (McGregor 1968). Cronquist (1980), however, considers *E. angustifolia* to be a variety of *E. pallida* (Nutt.) Nutt. (*i.e.* var. *angustifolia* (DC.) Cronq.) and *E. tennesseensis* to be an eastern outlier of this variety. Nevertheless, McGregor (letter, 27 Feb. 1981) wrote that, "I know *angustifolia* quite well and based on my observations of *tennesseensis* I just cannot merge the two as Cronquist insists must be done."

The closest relatives of *Lesquerella lyrata* are *L. densipila* Rollins and *L. auriculata* (Engelm. & Gray) Wats. *Lesquerella densipila* is confined to northwest Alabama and central Tennessee, where it occurs on open glade-like areas and along floodplains of streams and rivers, and *L. auriculata* is a plant of dry prairies in central Oklahoma and eastern Texas (Rollins 1955; Rollins and Shaw 1973). According to Rollins (1955), "*L. lyrata* provides the proper evolutional step from *L. auriculata* to *L. densipila* as well as a possible remnant of a more or less continuous distribution pattern that must have connected the Tennessee and southwest species in a past era."

Pediomelum subacaule is a morphologically and geographically distinct species that is not closely related to any other species of *Pediomelum.* It shows some affinities with *P. hypogaeum* (Nutt.) Rydb. (including var. *scaposa* (A. Gray) Rydb.), a species of Texas and western Oklahoma, northeastern New Mexico, eastern Colorado, western Nebraska and southeastern Wyoming (Ockenden 1965).

Penstemon tenuiflorus belongs to the Section Graciles which (presumably) ". . . has moved eastward from western temperate North America" (Pennell 1935). Within the Graciles, *P. tenuiflorus* is most closely related to *P. hirsutus* (L.) Willd. of midwestern and northeastern United States and adjacent Canada (Pennell 1935; Koelling 1964) and *P. oklahomensis* Pennell, an endemic of central and southern Oklahoma (Pennell 1935; Barkley 1977). In support of the close relationship between *P. tenuiflorus* and *P. hirsutus,* Koelling (1964) showed that crosses between the two yielded completely fertile hybrids. He proposed that *P. tenuiflorus* may be only a variety of *P. hirsutus.*

The relationships of *Solidago gattingeri* and *S. shortii* to other members of the genus are not well understood. Dr. Connie Taylor, who presently is studying *Solidago,* thinks (letter, 10 Dec. 1985) that both species possibly are related to *S. missouriensis* Nutt., a variable species primarily of grasslands from Texas to Canada. She speculates that both *S. gattingeri* and *S. shortii* may have evolved from *S. missouriensis* var. *fasciculata* Holz., the southeastern representative of the *S. missouriensis* complex.

In a study of the systematic relationships of *Talinum calcaricum,* Krebs (1971) proposed that it is an amphidiploid that originated from hybridization between two of the three diploid species, *T. appalachianum* Wolf, *T. calycinum* Engelm. and *T. mengesii* Wolf. *Talinum mengesii* is endemic to granite and sandstone outcrops in Tennessee, Alabama and Georgia (Carter and Murdy 1985), and *T. calycinum* is primarily a species of rock outcrops in western Illinois (Mohlenbrock 1955), Missouri (Steyermark 1963), Arkansas (Smith 1978), Texas (Correll and Johnston 1970), Oklahoma, Colorado and Nebraska (Barkley 1977). Although *T. appalachianum* previously was thought to be a narrow endemic of rock outcrops in central Alabama (Wolf 1939), recent evidence shows that plants from the Alabama populations are conspecific with *T. parviflorum* Nutt. of the Ozarks, Great Plains and southwestern United States (Carter and Murdy 1985; Murdy and Carter 1985). Thus, if Kreb's proposal for the origin of *T. calcaricum* is correct, one, or both, of the parents of this species has (have) an Ozarkian-western United States distribution.

Onosmodium molle subsp. *molle* is one of five taxa of the *Onosmodium molle* complex (Das 1965; Cochrane 1976). The other subspecific taxa in this complex are *O. molle* Michx. subsp. *occidentale* (Mack.) Cochrane, a plant of plains, prairies, open woods, limestone glades, and sand hills from Manitoba to Texas and from the foothills of the Rocky Mountains to Illinois and Georgia; *O. molle* Michx. subsp. *hispidissimum* (Mack.) Cochrane, a plant of woods, meadows, stream banks and limestone cliffs, and barrens from New York and Ontario to Minnesota south to western Virginia, Mississippi, and Arkansas; *O. molle* Michx. subsp. *bejariense* (DC.) Cochrane, a plant of flood plains, river banks, and woods in west central Texas; and *O. molle* subsp. *subsetosum*, a plant of limestone glades in the Ozarks of Missouri, Oklahoma, Arkansas, and central Tennessee (Das 1965; Smith 1978; Jones 1976; Baskin *et al.* 1983; Van Horn 1980; Patrick *et al.* 1983).

Das believes that (1) the center of diversity for *Onosmodium* is in the Texas–Missouri–Tennessee area, (2) this region may have served as a refugium for the genus during the Pleistocene and (3) secondary dispersal has occurred from this area. Today, one subspecies is endemic or nearly endemic to each part of Das' postulated refugium (*i.e.* subsp. *bejariense* to Texas, subsp. *subsetosum* to the Ozarks and subsp. *molle* to middle Tennessee). Subspecies *hispidissimum* and *occidentale* are the only two members of the complex (and the genus) that have migrated into glaciated territory, and they are less well differentiated than the three endemic varieties. Thus, Das (1965) postulates that in the distant geological past (1) *O. molle* or its immediate ancestor once had a continuous distribution from western Texas through the Ozarkian Region to Tennessee, (2) range disruption divided the species into three distinct geographical regions, (3) due to different selective forces the populations differentiated into *bejariense, subsetosum* and *molle,* (4) some time later *bejariense* gave rise to *occidentale* and *molle* to *hispidissimum,* (5) *occidentale* and *hispidissimum* greatly expanded their ranges into glaciated territory in postglacial times, and (6) speciation is continuing in the complex.

Delphinium alabamicum was thought by Kral (1976) to be closely allied with *D. carolinianum* Walt., a species of thinly-wooded and open habitats in southeastern and southcentral United States, and *D. tricorne* Michx., a species of rich mesic woodlands of eastern United States (Ewan 1945). On the basis of morphology and leaf flavonoid chemistry, however, Warnock (1982) concluded that *D. alabamicum* is most closely allied with *D. treleasei* Bush ex Davis, an endemic of dolomite glades on the Ozark Plateau of Arkansas and Missouri.

McVaugh (1936) regarded the endemic cedar glade lobelia as a species, *Lobelia gattingeri* A. Gray, but later reduced it to a variety of *L. appendiculata* A. DC. (McVaugh 1943a). *Lobelia appendiculata* var. *appendiculata* ranges from central Alabama to eastern Texas north to Arkansas, Oklahoma and eastern Kansas, and according to Bowden (1959a) it seems to be most closely related to *L. spicata* Lam. which occurs over a wide geographical area in eastern North America. Based on a combination of morphological differences, Bowden (1959b) concluded that *L. gattingeri* and *L. appendiculata* are distinct species. However, after crosses between the two taxa produced vigorous F_1 hybrids with no meiotic irregularities and a high percentage of viable pollen, Bowden (1961) concluded that the two taxa are closely related.

Eiten (1963) recognized three subspecies of *Oxalis priceae*, subsp. *priceae* endemic to southeastern cedar glades, subsp. *texana* (Small) Eiten of the southeastern coastal plain and subsp. *colorea* (Small) Eiten of the southeastern coastal plain and adjacent uplands. According to Eiten (1963), *Oxalis priceae* is most closely related to *O. dillenii* Jacq. subsp. *dillenii*, native to eastern United States and adjacent Canada and to the Rocky Mountains, and within *O. priceae* itself, subsp. *priceae* is most closely related to subsp. *colorea*. However, Dr. Robert Ornduff, who has studied North American *Oxalis*, believes that *O. priceae* subsp. *priceae* is a distinct species (letter, 31 July 1984) and that its nearest relatives (letter, 8 Nov. 1984) possibly are *O. grandis* Small, a woodland species of the eastern United States, and *O. suksdorfii* Trelease of the Pacific northwest.

Lourteig (1979) included *Oxalis priceae* Small (=*O. priceae* subsp. *priceae*) under *O. macrantha* (Trel.) Small. Her *O. macrantha* is not endemic to cedar glades of southeastern United States. The other two subspecies of *O. priceae* recognized by Eiten (1963) have been placed under other species by Lourteig, subsp. *texana* under *O. lyonii* Pursh and subsp. *colorea* under *O. florida* Salisb. subsp. *florida*.

Four taxa of cedar glade endemics in the southeastern United States, *Hypericum dolabriforme, Phacelia dubia* var. *interior, Orbexilum stipulatum* and *Viola egglestonii* seem to be most closely allied to taxa of eastern and/or midwestern United States. *Hypericum dolabriforme* has its closest relative in *H. sphaerocarpum* Michx. (Adams 1962) and *P. dubia* var. *interior* in the Appalachian species *P. dubia* var. *dubia* (Putman 1967). Since *O. stipulatum* was never collected in fruit, its taxonomic relationships are uncertain, and Rydberg (1919, 1926) even suggested that it might be a *Desmodium*. However, the appearance of *O. stipulatum* suggests that it is related to *O. onobrychis* (Nutt.) Rydb. (Isely 1962).

Constance (1949) included *Phacelia dubia*, along with 13 other species, in the subgenus *Cosmanthus* and speculated that this assemblage had migrated northward from Mexico. According to Gillett (1968), the present-day center of distribution and diversity of this assemblage is in eastern North America. Gillett (1968) concluded, on the basis of cytological, morphological, physiological, and phytogeographical evidence, that the 14 phacelias in subgenus *Cosmanthus* represent five distinct evolutionary "Groups." The granite outcrop endemic *P. maculata* Wood (Murdy 1966) and *Phacelia dubia* constitute Group IV, which has the lowest chromosome number ($n = 5$) among the *Cosmanthus* phacelias. Within this Group, the three varieties of *P. dubia* are fully interfertile, but none of them will hybridize with *P. maculata* (Murdy 1966; Putman 1967).

Concerning the geographical/evolutionary relationships of *Viola egglestonii*, Landon McKinney, who presently is studying the violets of eastern North America, offers the following speculation (letter, 14 Dec. 1985).

> "*Viola egglestonii* is one of a number of species of the acaulescent blue violets, section Plagiostigma, subsection Boreali-Americanae, limited in distribution to North America, the majority of which are limited to the eastern half of the U.S. They constitute an aneuploid group, all of which are hypertetraploids, have $n = 27$. They are likely the most recently evolved of the North American violets." "As for relationships within the group, those species limited in distribution and somewhat habitat specific are likely the youngest species or ecotypes. *Viola egglestoniii* is closely related morphologically to *V. septemloba*, a southern pine forest species. These species likely developed out of the *V. palmata* complex which likely centered within the Southern Appalachians, radiating outward and developing new ecotypes as they went."

DISCUSSION

The vegetation of the cedar glade region of the southeastern United States was a boreal Jack pine-spruce-fir forest during the full glacial interval of the Wisconsinan (23,000–16,500 years before present, YBP) and a mixed coniferous-deciduous forest during the late glacial interval (16,500–12,500 YBP) (Delcourt 1979; Delcourt and Delcourt 1979; Klippel and Parmalee 1982; Parmalee and Klippel 1982). Remains of prairie chicken, 13-lined ground squirrel and plains pocket gopher from a cave deposit in Maury County, Tennessee, suggest that by late glacial times, grasslands were interspered with the coniferous-deciduous forest in the Central Basin of Tennessee (Parmalee and Klippel 1981). Delcourt and Delcourt (1985) speculate that during the full and late glacial intervals, the climate north of northern Alabama may not have been suitable for the present-day cedar glade flora. However, we suggest that (1) throughout the southeastern cedar glade region (Fig. 1), the climate during these intervals may have been suitable for the persistence of many of the herbaceous species that today grow in cedar glades and (2) the cedar glade plant communities remained at least somewhat intact. Thirty taxa of vascular plants that grow in the southeastern cedar glades also grow in thin soil over flat limestone bedrock ("alvars") in southern Ontario, Canada (Catling *et al.* 1975), and 21 taxa grow in alvars on Drummond Island, Michigan (Herendeen 1985). Three taxa (*i.e. Isanthus brachiatus* (L.) BSP., *Sporobolus vaginiflorus* (Torr.) Wood and *Scutellaria parvula* Michx.) listed by C. Baskin and J. Baskin (1975) as characteristic cedar glade species of southeastern United States occur on alvars in both Ontario and Michigan. Perhaps significantly, *Juniperus communis* L., *J. virginiana* L., *Picea glauca* (Moench) Voss, *Pinus banksiana* Lamb. and *Thuja occidentalis* L. grow in the forest bordering the open alvars in southern Ontario (Catling *et al.* 1975), while the conifer-dominated forest in the alvar region of Drummond Island includes *Abies balsamea* (L.) Mill., *Larix laricina* (DuRoi) K. Koch, *P. glauca, P. resinosa* Ait. and *T. occidentalis* (Stephenson 1983; Herendeen 1985). Further, the historical ranges of *Astragalus tennesseensis, Dalea foliosa,* and *Pinus banksiana* overlap in northern Illinois (Sheviak 1981). Thus, endemic and nonendemic taxa of the present-day south/eastern cedar glade flora can persist in a climate that supports tree species of the boreal forest.

All 29 taxa of cedar glade endemics of southeastern United States occur in the Interior Low Plateaus Province of Alabama, Tennessee, and Kentucky, and only eight of these are found in the Ridge and Valley. Within the Ridge and Valley, cedar glade endemics are found only in Alabama, Georgia, and Tennessee, although glades or glade-like areas occur in Virginia and West Virginia. Interestingly, Bartgis (1985) reported that, although none of the cedar glade endemics occurs on the glade he studied in northeastern West Virginia, six mid-appalachian shale barren endemics (Keener 1983) do.

The only two species of cedar glade endemics in southeastern United States (as well as for the whole unglaciated eastern United States) whose geographical ranges extend north of the glacial boundary are *Astragalus tennesseensis* and *Dalea foliosa.* These two species have nearly identical ranges of distribution in the Southeast, and both are disjunct to central and northern Illinois. In addition, *A. tennesseensis* once grew in west-central Indiana. The habitats of these species in the glaciated territory are (were) dry prairies on thin soil over calcareous bedrock (Sheviak 1981; McFall 1984). An intriguing question is how these bicentric patterns of distribution developed. It seems reasonable to suggest that these two taxa migrated from the Southeast into the glaciated area in post-Pleistocene times. To explain the migration of these two species from the Southeast to the glaciated Midwest requires a migration route. One possible "corridor" could have been *via* limestone glades and outcrops of western Kentucky (Fig. 1) and southern Illinois (Kurz 1981) and the limestone ledges (Ozment 1967) and hill prairies (Evers 1955) along the Mississippi and Illinois Rivers. Although there are no records of *A. tennesseensis* or *D. foliosa* along this corridor between the northern part of the Central Basin of Tennessee and northcentral Illinois, it does not seem unreasonable that during the dry Hypsithermal interval of the mid-Holocene (King 1981) limestone ledges and hill prairies along the corridor, which even today support a xeric type of flora (Evers 1955; Ozment 1967), were suitable for the migration of *A. tennesseensis* and *D. foliosa*.

Evidence presented in this paper has brought out the fact that many of the endemics in the southeastern cedar glade flora are geographically/evolutionarily allied with species whose ranges are to the west of the Mississippi River. The western/southwestern element in the cedar glade flora of southeastern United States not only is represented by the endemics but also by western species whose ranges extend into the Southeast, where they are associated closely with limestone glades and glade-like areas. Examples of such species are *Grindelia lanceolata* Nutt., *Heliotropium tenellum* (Nutt.) Torr., *Evolvulus pilosus* Nutt., *Delphinium carolinianum* Walt. subsp. *virescens* (Nutt.) R. E. Brooks, *Dalea candida* (Michx.) Willd. var. *candida, D. purpurea* var. *purpurea, Onosmodium molle* subsp. *occidentale, Oenothera triloba* Nutt., *O. macrocarpa* Nutt. var. *macrocarpa, Aster sericeus* Vent., *Allium stellatum* Ker-Gawler, *Galium virgatum* Nutt., *Bouteloua curtipendula* (Michx.) Torr., and *Sporobolus heterolepis* Gray. All of these species also occur on limestone glades in the Ozarks (Steyermark 1940), and *E. pilosus* and *O. macrocarpa* var. *macrocarpa* are disjunct to middle Tennessee from the Ozark Plateau.

The facts that *Astragalus tennesseensis, Dalea foliosa* and *Pediomelum subacaule* are not closely related to any extant species in their genus and that *Leavenworthia* is not closely related to any extant genus suggest that these taxa evolved in the distant geological past. On the other hand, *Dalea gattingeri, Echinacea tennesseensis, Lobelia appendiiculata* var. *gattingeri, Onosmodium molle* subsp. *molle, Penstemon tenuiflorus,* and *Phacelia dubia* var. *interior* are closely related to extant taxa and may have evolved relatively recently. The endemic floras of the granite outcrops of the southeastern piedmont (McVaugh 1943b; Murdy 1966) and the mid-Appalachian shale barrens (Keener 1983) also contain taxa with obscure evolutionary relationships as well as ones that are closely related to extant taxa.

For endemic taxa of granite outcrops in the southeastern United States (McVaugh 1943b) and those of the mid-Appalachian shale barrens (Reveal 1968; Keener 1970, 1983) which have close affinities with western taxa, it has been proposed that they or their ancestors may have entered the Southeast from the Southwest. We propose that ancestors of the cedar glade endemic taxa of *Astragalus, Dalea, Delphinium, Echinacea, Lesquerella, Onosmodium, Pediomelum, Penstemon,* and *Talinum,* whose centers of distribution in North America are in the western United States, and *Leavenworthia,* which may be most closely related to the western genus *Selenia,* entered the Southeast from the Ozarks or Southwest.

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DISTRIBUTION PATTERNS OF THE NON-ENDEMIC FLORA OF MIDDLE TENNESSEE LIMESTONE GLADES

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ABSTRACT

The geographical and ecological distributions of the flora of Middle Tennessee limestone glades were compiled and analyzed. County distribution maps were prepared for selected taxa, with habitat and range data compiled for all taxa. This information was analyzed to determine generalized distribution patterns and habitat relationships for all species in the flora. Extraneous taxa comprised 19% of the native flora, with the majority having distribution centers to the west or northwest of the study area. Over half of the total flora was found to be characteristic of glades and prairies in other regions, with 19% specific to calcareous glades or rocky forests. The flora of limestone glades in Middle Tennessee was compared to published floras for 12 other glade types in the Southeast and Midwest. A moderate to high degree of similarity existed between the flora of the Middle Tennessee study area and those of limestone or dolomite glades in Kentucky, northern Alabama, northwest Georgia, southern Illinois, southern Indiana, and Missouri. Several examples of these distribution patterns and habitat relationships are presented.

INTRODUCTION

The Central Basin of Tennessee is an irregular basin about 96 km wide and 192 km long, extending across Tennessee from near the Kentucky border to its southern terminus in northern Alabama. The exposed surface rock of most of this region is Ordovician limestone or dolomitic limestone. Within the Central Basin, the geologic formation most often supporting open glades is the Lebanon Limestone, a flat, thin-bedded, flaggy, fossiliferous limestone of the Stones River Group (Wilson 1949). Safford (1869, 1884) first noted the existence of natural openings surrounded by red cedar (*Juniperus virginiana* L.) on this formation, and is credited with the application of the term "cedar glades" to these areas. This term has been perpetuated in the scientific literature (Freeman 1933; Quarterman 1950; Baskin *et al.* 1968) and common usage through the present. In the interest of consistency with ecological literature of surrounding regions, this paper will use the term "limestone glades" rather than "cedar glades" to describe these areas.

The ecological characteristics of Middle Tennessee limestone glades have been described by Freeman (1933) and Quarterman (1950). The flora of these glades is reasonably well known, with the published checklists of Baskin *et al.* (1968) and Baskin and Baskin (1975) summarizing the known flora at those dates. This study is primarily concerned with defining the phytogeographical patterns of this flora. Several limitations encountered in this study are similar to those described by Bare and McGregor (1970) in their comprehensive work on the phytogeography of Kansas, involving differences in collecting intensity, taxonomic concepts, and definition of patterns. A particular shortcoming of the present study is the lack of published distributional information on the flora of western Tennessee, Alabama, Mississippi, and Kentucky, and differing degrees of collection intensity within this region and adjacent states. Often it was difficult to determine if certain taxa were isolated in Middle Tennessee, or simply unreported from adjacent regions of other states. Another problem was attempting to correlate varying taxonomic concepts of certain taxa. Many phytogeographical studies (Parker 1936; Bare and McGregor 1970) avoid this problem by not considering taxa with taxonomic problems. Because of the importance of these problematic taxa in the glade flora, however, they were included following decisions as to how to treat them consistently for phytogeographical purposes. Nomenclature follows Kartesz and Kartesz (1980), with the exception of the genus *Delphinium,* which follows Warnock (1981).

METHODS

A floristic list for Middle Tennessee limestone glades was compiled from the published lists of Baskin *et al.* (1968) and Baskin and Baskin (1975), reports of additional species (Kral 1973, 1976, 1981, 1983), and recent collections, including those made by the senior author from 1983 through 1985. Distributional information, including both habitat and range data, was then compiled for each taxon. County distribution maps were prepared for all taxa which reached their range limits in or near the study area. Over 200 published floras, monographs, rare species publications, and other references were used in compiling distributional information. A complete list of the references and herbaria consulted is available from the authors. Particular emphasis was placed on the *Flora of Missouri* (Steyermark 1963) in compiling habitat and general range information.

The county distribution maps, habitat data, and general range descriptions were used to group the taxa into various distribution patterns. In defining distribution patterns, reference is made to the distribution center of each taxon. While some taxa have a fairly simple, narrow range and have total ranges corresponding closely to these general patterns, most have outliers in several directions from their centers of distribution. In defining distribution centers for these taxa, emphasis was placed on the density of county records relative to the known intensity of collecting and availability of information. Correlations of range limits with natural changes in habitat availability were used to define general distribution patterns for these taxa. Range maps of individual taxa show continual intergradation between any definable patterns, but attempts were made to combine closely related ranges into general patterns.

The first consideration in this process was whether the taxon could be considered intraneous or extraneous relative to the study area and immediately surrounding regions. Intraneous taxa are defined as those whose center of distribution includes Middle Tennessee and most of the surrounding regions. These taxa were divided into distribution patterns based first on their general range and secondarily on their degree of habitat fidelity. Extraneous taxa are defined as those whose center of distribution does not include Middle Tennessee. These include taxa disjunct to the study area and those which are peripheral, that is, reaching their range limit at or near Middle Tennessee. Extraneous taxa were divided into patterns first based on the direction of their distribution center from Middle Tennessee, and secondarily by the physiographic regions where they were most frequent. Generalized maps of each of these patterns were prepared based on the composite distributions of each species in the flora displaying that pattern.

The native flora of Middle Tennessee limestone glades was compared to that

Table 1. Geographical and ecological distribution patterns of the native flora of Middle Tennessee limestone glades.

Intraneous taxa

- I. Endemics or near–endemics (16)
- II. Distribution center in the Southeastern United States (47)
  - A. Restricted to upland provinces of the Gulf States and the Interior Low Plateaus (4)
  - B. Restricted to glades in the Interior Highlands, Ridge and Valley, and Interior Low Plateaus (3)
  - C. Southeastern glade, prairie, and open forest taxa (8)
  - D. Widespread southeastern taxa (32)
- III. Distribution center in temperate Eastern North America (130)
  - A. Characteristic of calcareous glades or rocky forests (7)
  - B. Characteristic of glades and prairies (54)
  - C. Various habitats, generally open dry areas (33)
  - D. Various habitats, generally moist or wet areas (15)
  - E. Widespread, weedy or opportunistic (21)
- IV. Distribution center in temperate North America (25)
  - A. Somewhat characteristic of glades and prairies (8)
  - B. Widespread, weedy or opportunistic (17)

Extraneous taxa

- I. Distribution centers to the west or northwest (35)
  - A. Great Plains (10)
    - 1. General Great Plains
    - 2. Southern Great Plains
    - 3. Great Plains and Ozark Plateaus
  - B. Interior Highlands (12)
    - 1. Salem and Springfield Plateaus
    - 2. Calcareous regions of Interior Highlands and Southern Great Plains
    - 3. General Interior Highlands and Southern Great Plains
  - C. Interior Highlands and Prairie Peninsula (13)
    - 1. Interior Highlands, Prairie Peninsula and Great Plains
    - 2. Interior Highlands and Prairie Peninsula
- II. Distribution center to the north (Till Plains and central Appalachians northward) (7)
- III. Distribution center to the east (Appalachian provinces eastward) (6)
- IV. Distribution center to the south (Gulf States or Coastal Plain) (4)

of 12 other glade types in the Southeast and Midwest. Published floristic checklists were compared on the species level and indices of similarity calculated for each. The glade floras utilized were: northern Alabama (Baskin *et al.* 1968), northwest Georgia (Baskin *et al.* 1968; Van Horn 1980), Kentucky "Barrens" region (Baskin and Baskin 1978; Johnson 1981), southern Indiana (Aldrich *et al.* 1981), southern Illinois (Kurz 1981), Missouri (Nelson and Ladd 1980), and Wisconsin (Curtis 1959). Indices of similarity were calculated using the formulas of Jaccard and Sorensen, as described in Mueller-Dombois and Ellenberg (1974). An additional index of similarity was calculated which provides a measure of floristic similarity independent of the relative sizes of the lists being compared, since the floristic lists used varied greatly in their level of completeness and number of sites surveyed. The formula for this index is: $IS = \frac{1}{2}[(c/B) + (c/A)]$ where A and B equal the number of species on the two lists, respectively, and c equals the number of species in common between the two lists. When floristic lists of equal sizes are compared with this formula, the result is the same as the Sorensen index of similarity.

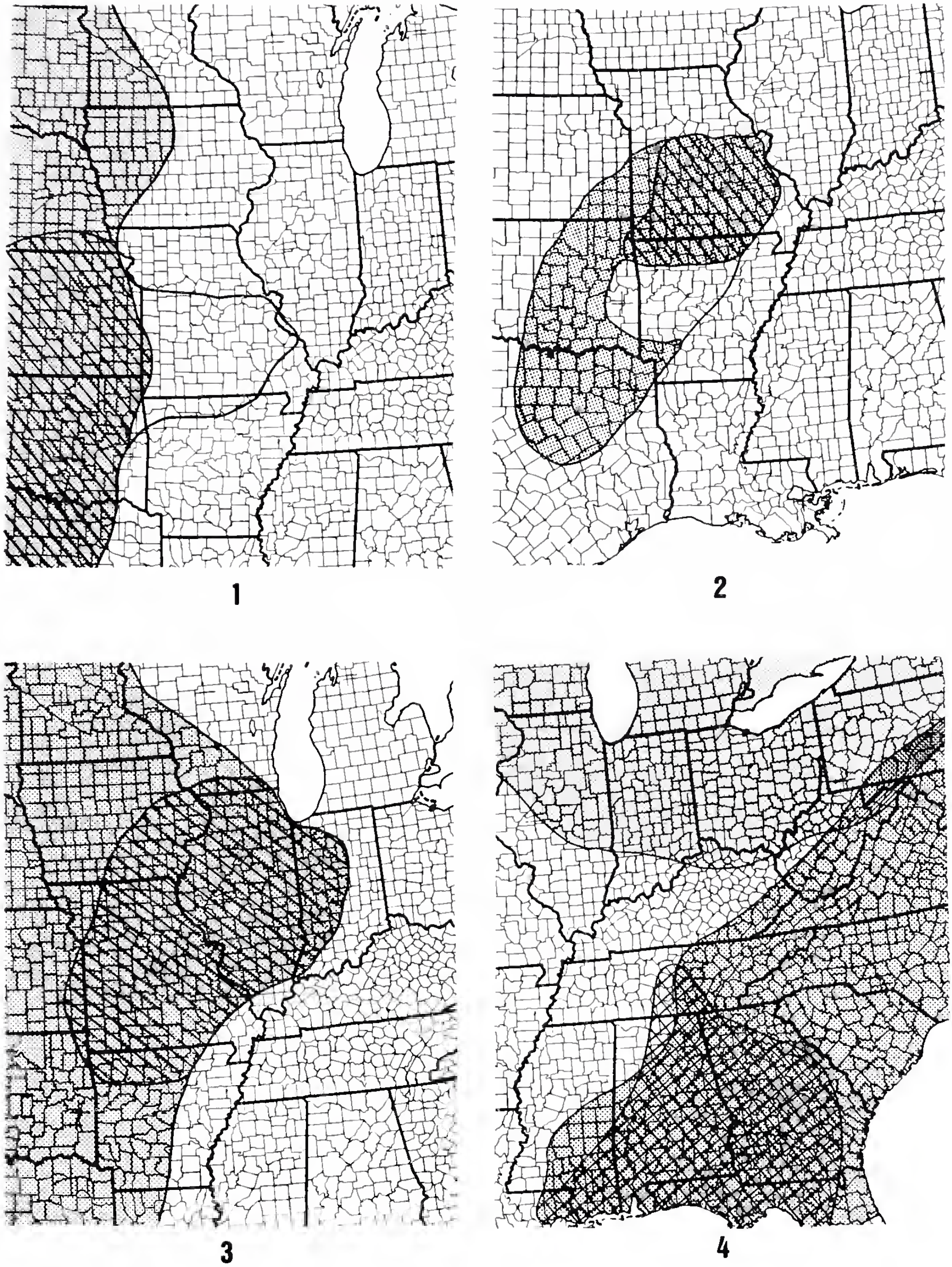
RESULTS

The floristic list used for this study was comprised of 348 taxa, and is available from the authors. Seventy-one taxa (20% of the total flora) were determined to be exotic, and seven (2%) are probably recent adventives to the region, primarily from the Central United States. Therefore, a total of 78 taxa (22%) were determined as non-native, leaving a total of 270 native taxa. The distribution patterns exhibited by the native flora are summarized in Table 1. Intraneous taxa included 16 endemics or near-endemics (6% of the native flora), and 202 taxa (74%) which are fairly common in Tennessee and adjacent states. Ranges of the non-endemic intraneous taxa fall into three broadly defined geographical patterns: southeastern United States (47 taxa; 17%), temperate Eastern North America (130 taxa; 48%), and temperate North America (25 taxa; 9%). The 52 extraneous taxa comprised 19% of the native flora; 35 of these (13%) had distribution centers to the west or northwest of Middle Tennessee, 7 (3%) had a northern distribution center, 6 (2%) were eastern, and 4 (1%) southern.

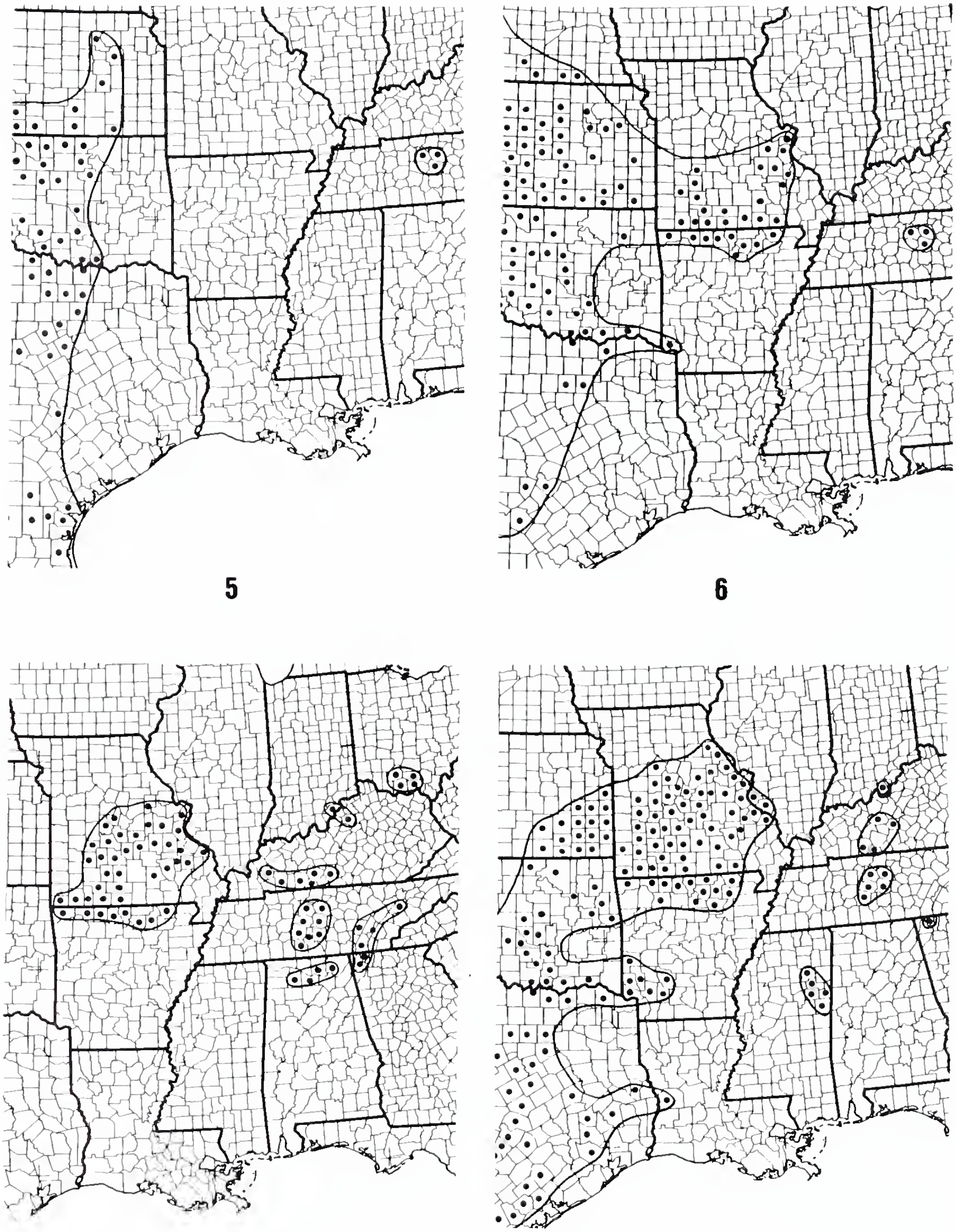
Species with a distribution center in the southeastern United states included 32 taxa which are fairly widespread in both range and habitats in the region. Examples of this type include *Amsonia tabernaemontana* Walt., *Brickellia eupatorioides* (L.) Shinners, and *Galactia regularis* (L.) B.S.P. Eight taxa are characteristic of glades, prairies, and rocky open woodlands in the Southeast. These include *Anemone caroliniana* Walt., *Cheilanthes lanosa* (Michx.) D. C. Eat., and *Manfreda virginica* (L.) Rose. *Minuartia patula* (Michx.) Mattf., *Ophioglossum engelmanii* Prantl, and *Sedum pulchellum* Michx. differ from the previous type in being mostly restricted to glades in the Interior Highlands, Interior Low Plateaus, and Ridge and Valley provinces. Four southeastern taxa (*Aster pilosus* Willd. var. *priceae* (Britt.) Cronq., *Hypericum frondosum* Michx., *Liatris squarrulosa* Michx., and *Silphium pinnatifidum* Ell.) are apparently restricted to the upland provinces of the Gulf states and the Interior Low Plateaus.

The most common distribution pattern in this study is that of taxa which are fairly widespread in temperate Eastern North America. These exhibit varying degrees of fidelity to calcareous glades and forests, glades and prairies, open dry habitats, or moist to wet habitats. Seven taxa are characteristic of calcareous glades or outcrops in rocky forests, including *Camassia scilloides* (Raf.) Cory, *Lithospermum canescens* (Michx.) Lehm., *Dodecatheon meadia* L., and *Polymnia canadensis* L. Fifty-four taxa are at least somewhat characteristic of glades and prairies, including *Aristida longespica* Poir., *Asclepias verticillata* L., *Carex granularis* Muhl. ex Willd., *Comandra umbellata* (L.) Nutt., *Glandularia canadensis* (L.) Nutt., *Helianthus mollis* Lam., *Nothoscordum bivalve* (L.) Britt., and *Sporobolus asper* (Michx.) Kunth. Thirty-three taxa have a wide range of habitat tolerance, generally occurring in open dry areas. Species in this category include *Andropogon virginicus* L., *Antennaria plantaginifolia* (L.) Richards., and *Helianthus divaricatus* L. Fifteen taxa which are most often found in moist to wet habitats occupy ephemerally wet areas on the glades. These include *Allium canadense* L., *Carex frankii* Kunth, *Polygonum scandens* L., and *Vernonia gigantea* (Walt.) Trel. ex Branner and Coville. The remaining 21 taxa are quite widespread, weedy, or opportunistic, and include *Asclepias syriaca* L., *Eragrostis spectabilis* (Pursh) Steud., *Oenothera biennis* L., and *Solidago canadensis* L.

The 25 taxa which are widespread in temperate North America include eight which are somewhat characteristic of glades and prairies. Examples of this group



Figs. 1–4. Distribution centers of extraneous taxa of Middle Tennessee limestone glades. Fig. 1: Great Plains distribution centers—a) General Great Plains (shaded area); b) Southern Great Plains (hatched area); c) Great Plains and Ozark Plateaus (west of solid line). Fig. 2: Interior Highlands distribution centers—a) Salem and Springfield Plateaus (hatched area); b) Calcareous areas of Interior Highlands and Southern Great Plains (shaded area); c) General Interior Highlands and Southern Great Plains (bordered by solid line). Fig. 3: Interior Highlands and Prairie Peninsula distribution centers—a) Interior Highlands, Prairie Peninsula, and Great Plains (shaded area); b) Interior Highlands and Prairie Peninsula (hatched area). Fig. 4: Northern, Eastern, and Southern distribution centers—a) Northern (light shaded area); b) Eastern (dark shaded area); c) Southern (hatched area).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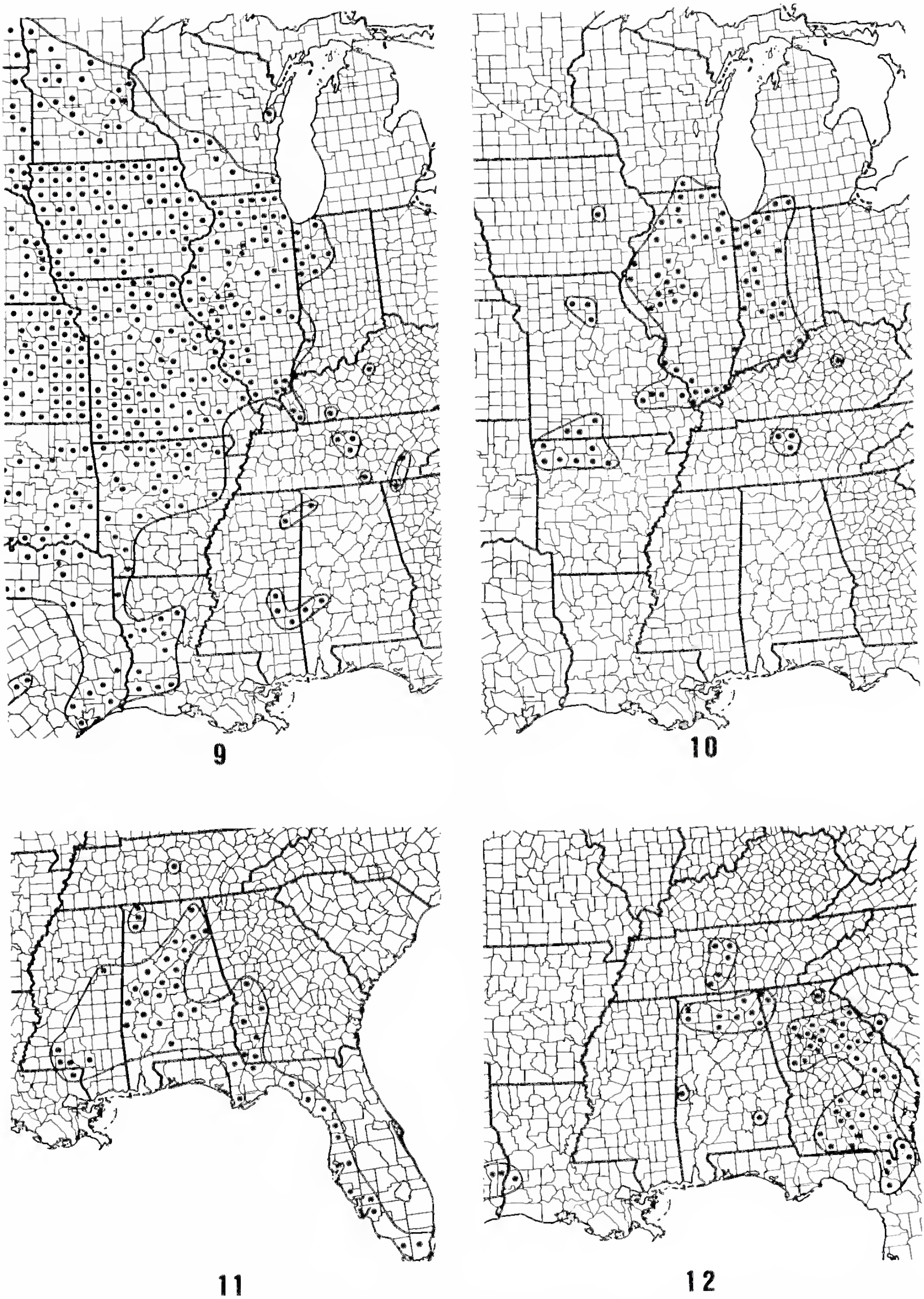
Figs. 5–8. County distribution and general ranges of selected taxa with Great Plains and Interior Highlands distribution centers. Fig. 5: *Ammoselinum popei*. Fig. 6: *Evolvulus pilosus*. Fig. 7: *Leavenworthia uniflora*. Fig. 8: *Heliotropium tenellum*.

include *Andropogon gerardii* Vitman, *Apocynum cannabinum* L., *Bouteloua curtipendula* (Michx.) Torr., *Schizachyrium scoparium* (Michx.) Nash, and *Sorghastrum nutans* (L.) Nash. The remaining 17 taxa are weedy and opportunistic, including *Ambrosia artemesiifolia* L., *Bidens bipinnata* L., *Galium aparine* L., and *Rudbeckia hirta* L.



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Figs. 9–12. County distribution and general ranges of selected taxa with Interior Highlands and Prairie Peninsula and Southern distribution centers. Fig. 9: *Dalea candida.* Fig. 10: *Phlox bifida.* Fig. 11: *Polygala boykinii.* Fig. 12: *Schoenolirion croceum.*

Extraneous taxa were grouped by the direction of their distribution centers from Middle Tennessee. By far the largest number of extraneous taxa have distribution centers to the west or northwest of the study area. These can be divided into three general patterns: Great Plains (10 taxa), Interior Highlands (12), and Interior Highlands and Prairie Peninsula (13). The general patterns of Great Plains distribution centers are shown in Fig. 1. Three subpatterns are recognized: general Great Plains, southern Great Plains, and Great Plains plus Ozark Plateaus. Only two taxa, *Mirabilis linearis* (Pursh) Heimerl and *Delphinium carolinianum* Walt. ssp. *penardii* (Huth) Warnock, are distributed throughout the Great Plains and are sporadic eastward. Three taxa, *Ammoselinum popei* Torr. & Gray (Fig. 5), *Carex microdonta* Torr. & Hook., and *Juncus filipendulus* Buckley, are found primarily in the southern Great Plains. Five taxa are distributed primarily in the Great Plains and on the Ozark Plateaus (*i.e.* Salem and Springfield Plateaus). These are *Allium stellatum* Ker-Gawl., *Baptisia australis* (L.) R. Br. var. *minor* (Lehm.) Fern., *Evolvulus pilosus* Nutt. (Fig. 6), *Mirabilis albida* (Walt.) Heimerl, and *Oenothera missouriensis* Sims.

Twelve taxa have distributions which center on the Interior Highlands, with three intergrading subpatterns (Fig. 2). One subpattern includes those taxa which occur primarily in the Salem and Springfield Plateaus of the Ozark Uplift. Examples of this type include *Leavenworthia uniflora* (Michx.) Britt. (Fig. 7) and *Onosmodium molle* Michx. ssp. *subsetosum* (Mackenzie & Bush) Cochrane. Other taxa, including *Galium virgatum* Nutt., *Heliotropium tenellum* (Nutt.) Torr. (Fig. 8), and *Oenothera triloba* Nutt., are distributed primarily in the calcareous regions of the Interior Highlands and Southern Great Plains, including the Blackland Prairie regions of the West Gulf Coastal Plain. Several taxa are found throughout much of the Interior Highlands and Southern Great Plains. Examples include *Calamintha glabella* (Michx.) Benth. (*sensu lato,* including *Calamintha arkansana* (Nutt.) Shinners), *Grindelia lanceolata* Nutt., *Dicanthelium malacophyllum* (Nash) Gould, and *Astranthium integrifolium* (Michx.) Nutt.

Thirteen taxa have distributions which center on the Interior Highlands and the "Prairie Peninsula" of Illinois and Indiana, often with outlying stations to the east and south (Fig. 3). Examples include *Dalea candida* (Michx.) Willd. (Fig. 9), *Cacalia plantaginea* (Raf.) Shinners, *Phlox bifida* Beck (including ssp. *stellaria* (Gray) Wherry; Fig. 10), *Liatris cylindracea* Michx., and *Hypericum sphaerocarpum* Michx.

Seven extraneous taxa were determined to have distribution centers to the north of Tennessee (Fig. 4). These tended to be at their southern periphery in Middle Tennessee, but not disjunct to the region. Examples include *Carex crawei* Dewey and *Penstemon hirsutus* (L.) Willd. Similarly, six taxa with eastern distribution centers are at or near their western periphery in Middle Tennessee. These include *Aster undulatus* L., *Matelea carolinensis* (Jacq.) Woods., and *Penstemon canescens* (Britt.) Britt.

Unusual distribution patterns were exhibited by four species primarily found south of the study area (Fig. 4). Of these, *Spermolepis divaricata* (Walt.) Britt. is primarily found throughout the southern Atlantic and Gulf Coastal Plains. The other three species are of more restricted distribution. *Polygala boykinii* Nutt. (Fig. 11) and *Lithospermum tuberosum* Rugel ex DC. are found primarily in regions of the Gulf States with calcareous substrates, and *Schoenolirion croceum* (Michx.) Wood (Fig. 12) is found mostly on acidic glades and in pine savannahs.

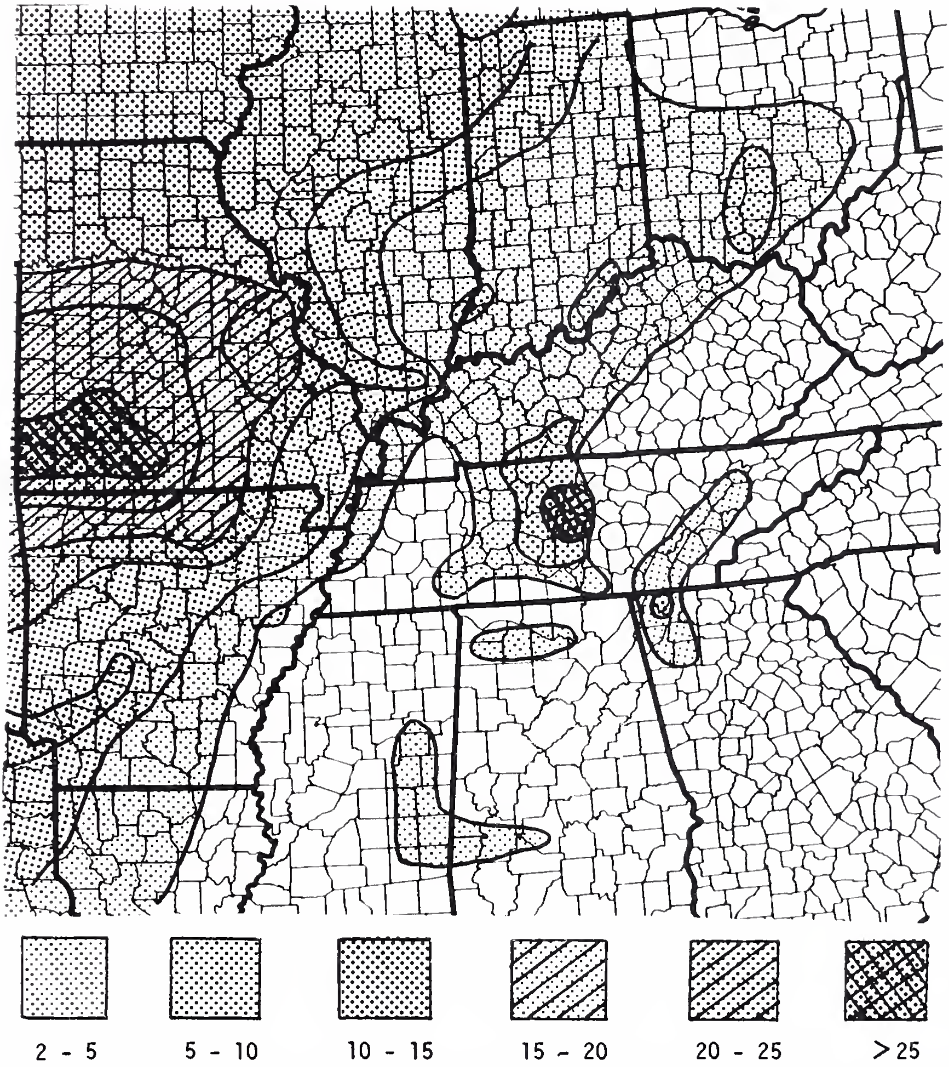

Fig. 13. Frequency distribution of 35 taxa of Middle Tennessee limestone glades with distribution centers to the west or northwest. Shadings indicate average number of species per county.

When the composite county distributions of the 35 taxa with distribution centers to the west or northwest are mapped (Fig. 13), their frequency distribution can be correlated with areas of glade and prairie occurrence near Middle Tennessee. Nearby limestone glade regions in northern Alabama, northwest Georgia, and southern Kentucky have a higher concentration of these species than other counties near the study area. Similarly, glade and prairie regions in southern Ohio, Indiana, and Illinois, as well as the Blackland Prairie regions of Alabama, Mississippi, and Arkansas stand out as other areas of similar range disjunctions or peripheral stations of species with west or northwest distribution centers. The majority of these 35 taxa are not present within a single county outside of Middle Tennessee, east of the Salem and Springfield Plateaus. Only in southwestern Missouri can

Table 2. Floristic comparison of Middle Tennessee limestone glades with other glade types (see text for sources). A = number of native species in Middle Tennessee limestone glades, IS_J = Jaccard index of similarity, IS_S = Sorensen index of similarity.

Location and Substrate	total species (B)	sp. in common (c)	# on either (A+B−c)	IS_J $(\frac{c}{A+B-c})$	IS_S $(\frac{2c}{A+B})$	% in TN $(\frac{c}{B})$	% of TN $(\frac{c}{A})$	IS $\frac{1}{2}(\frac{c}{B}+\frac{c}{A})$
Northern Alabama Limestone	81	70	281	.25	.40	86	26	.56
Northwest Georgia Limestone	102	82	290	.28	.44	80	30	.55
Kentucky "Barrens" Limestone	134	113	291	.39	.56	84	42	.63
Southern Indiana Limestone	62	40	292	.14	.24	65	15	.40
SE Illinois ILP Limestone	104	65	309	.21	.35	63	24	.43
SW Illinois Ozark Limestone	136	66	340	.19	.33	49	24	.36
S Illinois – Total Limestone	187	92	365	.25	.40	49	34	.42
Missouri Limestone	139	64	345	.19	.31	46	24	.35
Missouri Dolomite	227	88	409	.22	.35	39	33	.36
MO – Limestone + Dolomite	252	94	428	.22	.36	37	35	.36
Missouri Sandstone	135	46	359	.13	.23	34	17	.26
Missouri Igneous	122	51	341	.15	.26	42	19	.30
Missouri Chert	79	24	325	.07	.14	30	09	.20
MO – Sandstone + Igneous + Chert	177	61	386	.16	.27	35	23	.29
Missouri – Total all substrates	368	122	516	.24	.38	33	45	.39
Wisconsin Limestone	58	22	306	.07	.13	38	08	.23

one find a concentration of these taxa equal to or greater than that in the center of the Middle Tennessee glade region.

The native flora of the limestone glades of Middle Tennessee was compared with published floras of 12 glade types in the southeastern and midwestern United States (Table 2). The highest degree of similarity (IS = 0.63) was with limestone glades in the Kentucky "Barrens" region, only about 100 km north of the center of the study area. Similarity was almost as high with the limestone glades of northern Alabama (IS = 0.56) and northwest Georgia (IS = 0.55), both approximately 150 km distant. Limestone glades in the Interior Low Plateaus province in southern Illinois and southern Indiana, each about 250 km from the study area, had indices of similarity of 0.43 and 0.40, respectively. Limestone and dolomite glades in Missouri and limestone glades in the Ozark region of Illinois had similar indices of similarity, from 0.35 to 0.36, and occur from 350 to 650 km from Middle Tennessee. Glades on acidic substrates in Missouri were less similar to Middle Tennessee limestone glades (IS ranging from 0.20 to 0.30) than were calcareous glades in Missouri. In summary, floristic similarity tended to decrease with distance from the study area and with differing glade substrates, as expected.

When the habitat information for the entire native glade flora was summarized regardless of distribution pattern, 52 taxa (19%) were found to be characteristic of calcareous glades, prairies, or rocky forests. An additional 84 taxa (31%) were characteristic of glades and prairies, but not specific to calcareous substrates. Ninety-four taxa (35%) occupied a wide range of habitats, but are not considered to be of a weedy nature. Fifteen percent of the native flora (40 taxa) is composed of weedy and opportunistic species. Therefore, 50% of the native flora is at least somewhat characteristic of glades and prairies, but 15% of the native flora and 34% of the total flora is composed of exotic, adventive, or native weedy species.

Further research and collecting is likely to close some of the distribution gaps noted in this study; the majority of the extraneous taxa, however, are expected to remain infrequent in the regions surrounding the limestone glades. The distribution patterns of the non-endemic flora add to the evidence provided by the endemic flora supporting the floristic uniqueness of the limestone glades of Middle Tennessee.

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WOODY VEGETATION IN THE INNER NASHVILLE BASIN: AN EXAMPLE FROM THE CHEEK BEND AREA OF THE CENTRAL DUCK RIVER VALLEY

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ABSTRACT

Woody stems larger than 2.5 cm dbh were sampled on 53 plots 10 × 20 m laid parallel to contour in 7 forest stands. Relative basal area and relative density data were summed to provide importance values (IV) for species. Data for stands were subjected to ordination by principal coordinates analysis and to classification by a hierarchical agglomerative algorithm. The primary ordination axis seems to be related to a moisture gradient, while the secondary axis seems related to a complex of disturbance and soil fertility. Even though the vegetation sampled was successionally unstable, its classification is consistent with field experience and its ordination reflects dominant environmental influences and recent disturbance.

INTRODUCTION

The gentle crustal flexure known as the Cincinnati Arch has produced, through accelerated erosion of its two anticlinal limbs, the Bluegrass Region of Kentucky and the Nashville Basin of Tennessee. The thin-bedded and nearly pure Ordovician limestones given exposure through erosion support the celebrated cedar barrens and glades and associated richer forests. The plant communities of the Basin have been sampled recently by McKinney and Hemmerly (1984), while the communities of glades have been studied by Quarterman (1948, 1950) and Pearsall *et al.* (1985). Glade succession was studied by Picklesimer (1926) and more general ecological succession was studied by Quarterman (1957). Virtually none of the area has been spared the impact of modern man, and much of it has been maintained in farmland or pasture or has been timbered or burned recently (USTVA 1983). Although attractive to botanists because of disjuncts and endemics, the area has not been the subject of many plant community studies. Earlier studies have neither quantified relationships between environmental factors and community characteristics nor incorporated the powerful techniques of ordination and multivariate classification now available. Our objectives were to sample and characterize the composition and distribution of available forest communities from diverse topographic and geologic settings in the Cheek Bend Area of the Central Duck River Valley in the Inner Nashville Basin, seeking mature (albeit disturbed or seral) stands where available. Our samples included cedar glades and adjacent communities, and ranged from streamside habitats to topographic highs. This paper, thus, presents cedar glades in their broader vegetational context.

From plot data we calculated importance values for species by samples and

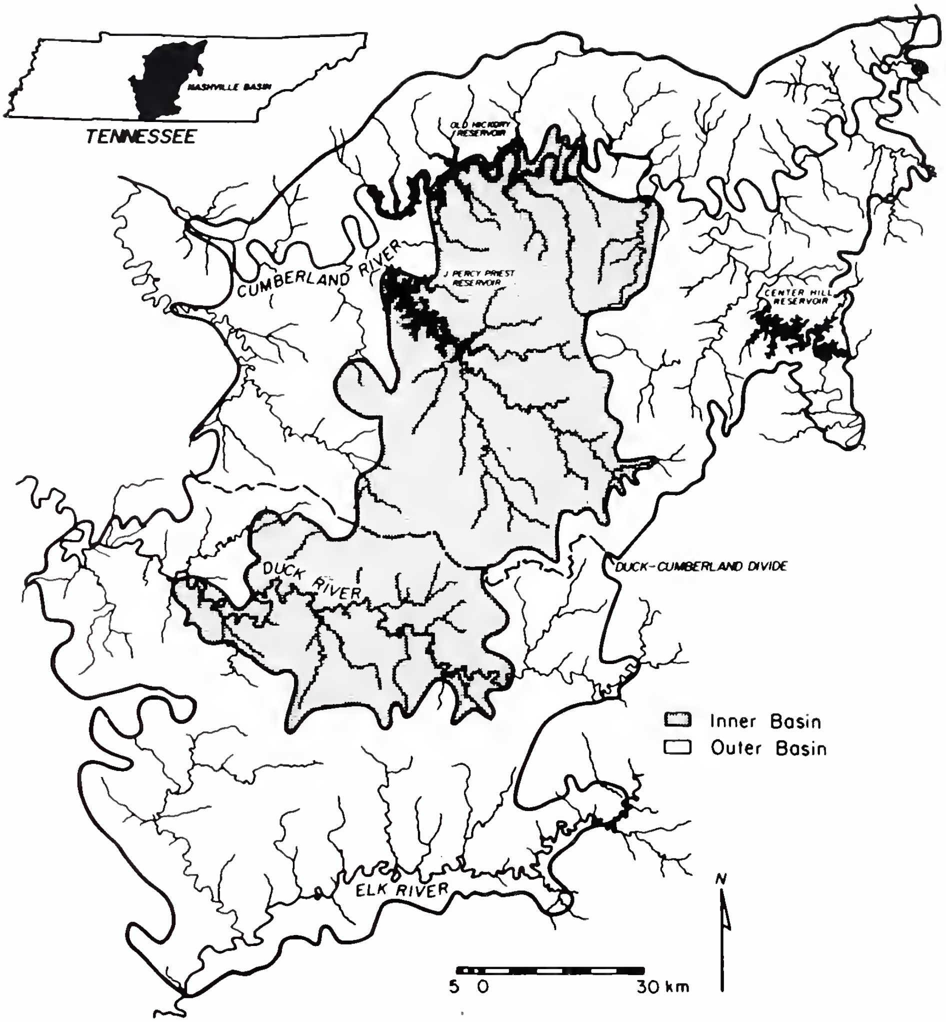

Fig. 1. Map of Inner and Outer Nashville Basin showing Cumberland, Duck, and Elk river drainages.

subjected the data to ordination by principal coordinates analysis (Gower 1966) and classification by Ward's clustering algorithm (Ward 1963; Anderberg 1973).

THE STUDY AREA

The Nashville Basin covers some 15,300 km^2 (ca. 170 km north/south by 104 km east/west—Edwards *et al.* 1974). Subdivisions of the Basin have been suggested in vegetational and floristic studies (Braun 1950; Quarterman 1948, 1950; DeSelm 1959), soil mapping (Edwards *et al.* 1974; Harmon *et al.* 1959), and topographic or physiographic studies (Fenneman 1938). In this report, the demarcation between Inner and Outer Basin is taken to be at the base of the Ordovician Hermitage formation (Fig. 1). Ordovician rocks above this line are consistently higher in phosphates than those underlying it. This difference influences soil fertility (higher fertility in the Outer Basin—Edwards *et al.* 1974).

Climatic data for the area indicate temperate humid conditions with an average annual temperature of 15 C and average annual precipitation of 1385.8 mm. Rainfall is fairly well distributed with evaporation peaking in mid-summer (Hofman 1984). When evaporation peaks and is accompanied by a drop in precipitation, drought stress soon becomes evident in some areas. The effect of summer drought stress on deciduous taxa is sometimes dramatic in upland areas. Killing frosts have occurred as early as 1 October and as late as 27 April. The average frost free season lasts 192 days (Harmon *et al.* 1959).

The Interior Low Plateaus are conterminous with the Western Mesophytic Forest region of Braun (1950). This forest region is characterized as a broad transition between the Mixed Mesophytic Forest of the Cumberland and Alleghany Plateaus and the Oak-Hickory forest of the Mississippi Embayment. Within this forest region the Nashville Basin section is one of six distinguished by Braun.

Westward from the eastern areas of the Western Mesophytic Forest there is an increasing frequency of oak dominated communities, accompanied by a loss of taxa characteristic of the Mixed Mesophytic Forest (*e.g. Tilia heterophylla* Vent. and *Aesculus octandra* Marshall) and replacement of *Quercus prinus* L. by *Quercus muehlenbergii* Engelm. on limestone-derived soils. Edaphic subclimaxes are a common feature in the upland areas of the Nashville Basin.

In the rolling parts of the Outer Basin, where soils are generally deeper, *Quercus alba* L., *Liriodendron tulipifera* L., and *Acer saccharum* Marshall are principal taxa on knolls and slopes (Braun 1950). Earlier references to Nashville Basin forests refer to the abundance and enormous size of trees growing on deeper soil in the Outer Basin. Principal timber taxa included *Fraxinus, Populus, Juglans nigra, Carya, Fagus, Acer,* and *Juniperus virginiana* L. Trees indicated as abundant in original forest include *Aesculus, Celtis, Gymnocladus dioica* (L.) K. Koch, and *Liquidambar styraciflua* L. (Killebrew and Safford 1898; Safford 1884; Sargent 1884). Killebrew and Safford (1874) indicate enormous sizes (seven feet in diameter) for *Carya, Acer, J. nigra, Ulmus,* and *L. tulipifera.*

Today only fragments of the Basin's original mesophytic forest remain. With the exception of some oak-hickory ridges and cedar glades, the Nashville Basin has been cleared. Choice trees were cut decades ago and young growth was cut repeatedly as stems attained a diameter sufficient for fence posts (Quarterman 1948).

The Inner Basin exhibits a vegetation which is generally more heterogeneous or patchy than that of the Outer Basin. This patchiness is effected by the close association of horizontal layers of exposed Lebanon limestone, shallow soils, and cedar glade growth (Quarterman 1948, 1950). The undulating upland surface of the Inner Basin (generally <7% slopes) exhibits shallow, somewhat poorly drained soils with very little surface drainage. Karst features such as caves, sinkholes, and vertical fissures in the bedrock do, however, afford substantial subterranean drainage. Soil depth to bedrock in the Inner Basin is substantially less than in the Outer Basin. 'Gladey land,' or areas of smooth, exposed limestone outcrops occupy 40% to 90% of the surface area (Edwards *et al.* 1974) of the Basin. Cedar glade plant communities occupy approximately six percent (ca. 918 km^2) of the Basin and occur mostly in Wilson, Maury, and Rutherford Counties (Safford 1884; Galloway 1919; Quarterman 1948). The Lebanon limestone in these areas (as well as much of the surrounding Ridley limestone) is overlaid by shallow (<30 cm) Rockland soils. The heterogeneous environment just described is manifest in Cheek Bend.

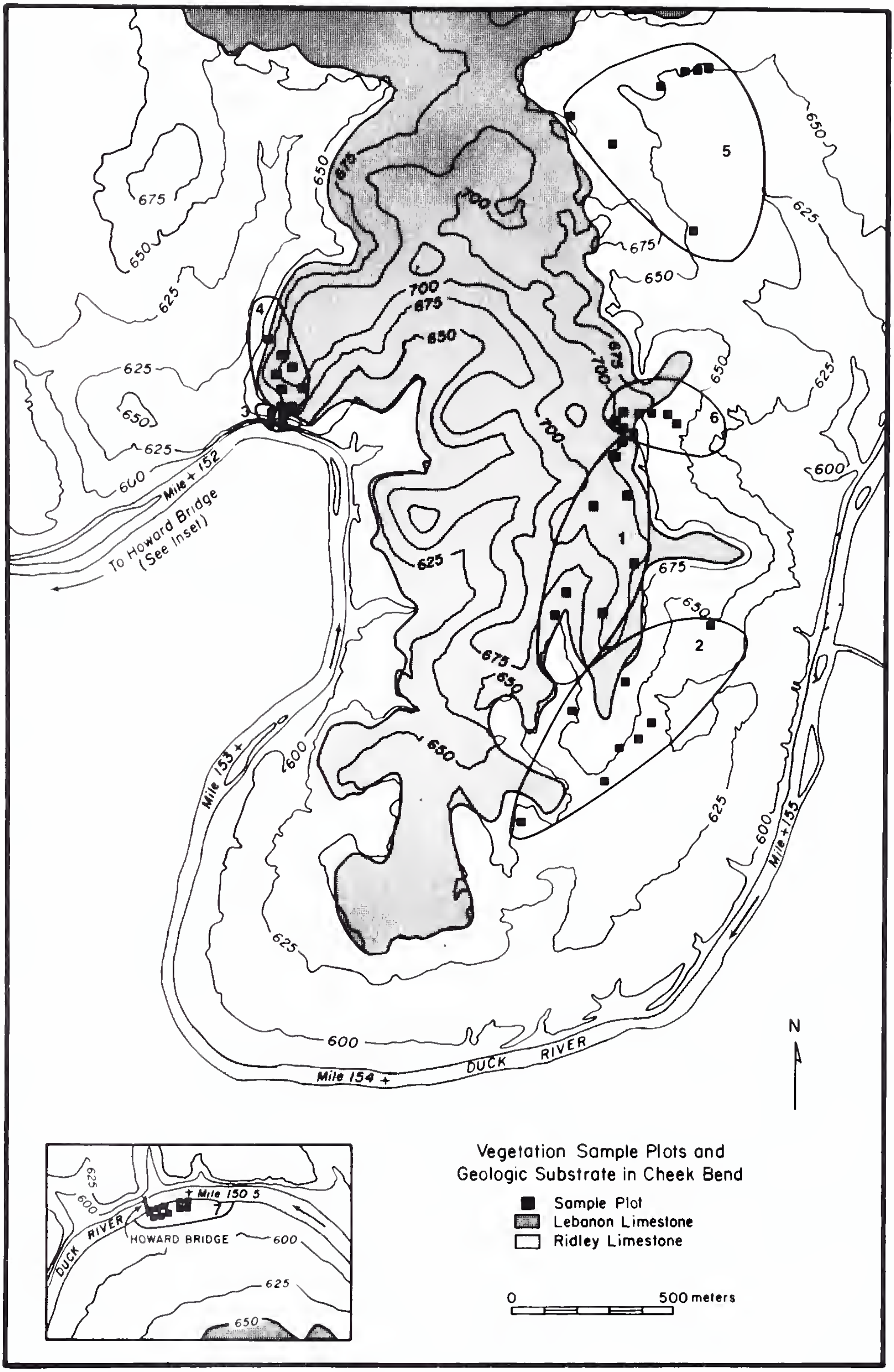

Fig. 2. Vegetation plots in stands on geologic substrates in Cheek Bend.

Table 1. Importance value difference between species on Lebanon and Ridley limestones in Cheek Bend.

Genus/species	Lebanon	Ridley	Difference
Acer saccharinum L.	7.6	18.9	19.5
A. saccharum	0.2	19.7	11.3
A. negundo		6.5	6.5
Aesculus glabra	0.1		0.1
Ailanthus altissima		0.5	0.5
Bumelia lycioides	0.3		0.3
Carya cordiformis		0.4	0.4
C. glabra	9.8	0.8	9.0
C. ovata	27.0	16.2	10.8
C. tomentosa	1.2	0.3	0.9
Carpinus caroliniana		0.2	0.2
Celtis occidentalis L.	1.2	6.3	5.1
Cercis canadensis L.	5.3	4.1	1.2
Cornus florida		4.9	4.9
Diospyros virginiana	1.0	0.9	0.1
Fraxinus americana	31.3	21.1	10.2
F. pennsylvanica Marshall	0.6	9.1	8.5
F. quadrangulata	1.0	0.8	0.2
Gleditsia triacanthos	0.2	0.8	0.6
Juglans cinerea		0.1	0.1
J. nigra	1.8	2.2	1.5
Juniperus virginiana	45.4	23.4	22.0
Morus rubra	0.9	1.1	0.2
Ostrya virginiana	8.6	8.4	0.2
Platanus occidentalis L.		21.1	21.1
Ptelea trifoliata		0.2	0.2
Quercus alba	3.8	0.7	3.1
Q. coccinea	0.1		0.1
Q. falcata	0.4		0.4
Q. muehlenbergii	16.1	10.6	5.5
Q. rubra L.		1.5	1.5
Q. shumardii	0.1		0.1
Q. stellata Wang.	8.2		8.2
Q. velutina	9.9	4.7	5.2
Rhamnus caroliniana	2.1	1.5	0.6
Salix nigra		1.1	1.1
Sassafras albidum	0.2		0.2
Ulmus alata	6.4	1.6	4.8
U. americana	3.0	0.5	2.5
U. rubra Muhl.	5.0	8.7	3.7
U. thomasii	1.0	0.2	0.8
Viburnum rufidulum	0.1		0.1

SAMPLING METHODS

Our approach to locating 'representative' vegetation samples was to subjectively select stands and objectively (randomly) place sample quadrats within the stands. A stratified random sampling procedure was employed which differentiated the area on the basis of geologic substrate. The extensive and severe disturbance of vegetation in the survey area made subjective selection of stands on each limestone formation the only viable approach to locating sample units. Sample plots were

Table 2. Geological, topographic, edaphic, and vegetational characteristics of the seven sample stands.

Stand number	Number of plots	Geological formation	Elevational range (feet)	Slope aspects	Slope angle range (°)
1	8	Lebanon ls.	660–705	SE, E, NE, W	3–16
2	8	Ridley ls.	635–665	SE, E, SW	2–8 (16)
3	4	Ridley ls.	605–625	SW, S	19–23
4	8	Lebanon ls.	685–705	SW, W, SE, S	3–11
5	7	Ridley ls.	645–670	E, S, SE	4–7
6	8	Lebanon/Ridley lss.	660–700	SE, E, NE	1–10
7	10	Ridley ls.	575–590	NW, N	1–24

randomly placed in selected stands located on each geologic formation (Fig. 2). Fifty-three 200 m^2 quadrats (20 m × 10 m) were randomly placed on the landscape, parallel to contour lines. These quadrats and the seven stands they constitute effectively sampled major topographic features in the area (*i.e.* bottomland, slopes, and uplands). Because vegetation tends to 'clump,' placing quadrats between contour lines reduced within-sample heterogeneity while increasing heterogeneity between samples. Within each quadrat, all woody stems at least 2.5 cm dbh (diameter at breast height—1.5 m) and greater than 1.5 high were measured.

Species/area curves showed the sample size to be adequate. Slope direction was obtained by compass, and slope angle was obtained by clinometer. Slope corrections were made by multiplying plot length by slope secant.

For each sample plot the following information was tabulated: (1) density, (2) relative density, (3) basal area, (4) relative basal area, and (5) importance value. This same information was tabulated for each of the seven stands. The sum of relative density and relative basal area yields an importance value between 0 and 200.

SAMPLING RESULTS

Plot and stand data were used to determine comparative importance values of all tree taxa encountered on Lebanon and Ridley limestones. However, since this pilot survey was intended to provide a characterization of the forest cover in Cheek Bend, only those species on Lebanon and Ridley limestone with the importance value *difference* of at least 1.0 were selected for ordination and classification analyses (Table 1).

Stand Descriptions

Table 2 includes, for each of the seven sampled stands, the geological formation, the range of elevations represented in the plots in each stand, the slope aspect (in decreasing order of frequency among plots in each stand), slope steepness, the names of soil series present in each stand, the number of woody plant species

Table 2. Extended.

Soil series names	# spp. sampled	Dominant trees (order of importance value)
Rockland Talbott	27	*Fraxinus americana, Juniperus virginiana, Carya ovata*
Rockland Talbott	20	*Juniperus virginiana, Carya ovata, Fraxinus americana*
Rockland	17	*Cornus florida, Quercus muehlenbergii, Ostrya virginiana*
Rockland	21	*Carya ovata, C. glabra, Juniperus virginiana, Quercus muehlenbergii*
Rockland Hermitage Talbott	18	*Acer saccharum, Fraxinus americana, Ostrya virginiana*
Rockland Talbott	19	*Juniperus virginiana, Fraxinus americana, Quercus muehlenbergii*
Egam Huntington	15	*Acer saccharum, Platanus occidentalis, Fraxinus pennsylvanica*

which met our size for sampling, and the names of dominant woody plants in the stand (in decreasing order of Importance Value).

ORDINATION

Principal coordinates analysis (Gower 1966), a generalization of principal components analysis, was used for the Cheek Bend data. It computes principal components from any Euclidean distance matrix. The distance matrix for seven stands in Cheek Bend was based on importance values for those 22 tree species with importance value differences of >1.0 between Lebanon and Ridley limestone sample sites. Selected species displayed the largest importance value variation between geologic substrates and thus were considered more representative of species variability on each formation.

When ordination of the Cheek Bend samples is viewed in terms of importance values and concomitant habitat data, a pattern of relationships emerges (Fig. 3). A moisture gradient may be inferred from the distribution of stands along the primary (x) axis. Information on geology, soil characteristics, and species dominance supports such an inference, with stand six representing the dry end of the continuum and stand seven the moist end (Table 2). The relative location of stands five and three along the x axis is somewhat problematic (less separation was expected) until examination of the species' importance values reveals that the relatively large number of small stems of *Cornus florida* L. and *Ostrya virginiana* (Miller) K. Koch in stand three gives them greater importance values than might be expected. This situation is probably an effect of disturbance history (our notes indicate that seedlings and saplings of these species are extremely rare in stand three).

Inferring an environmental gradient from the relative positions of stands along the second (y) axis is more problematic. While disturbance factors are undoubtedly influencing the ordering of stands along this axis, a soil fertility gradient seems to be exerting greater influence. If stands are then arranged in a hyperspace of axes which are oblique in relation to the conventional gradient axes, it is easier

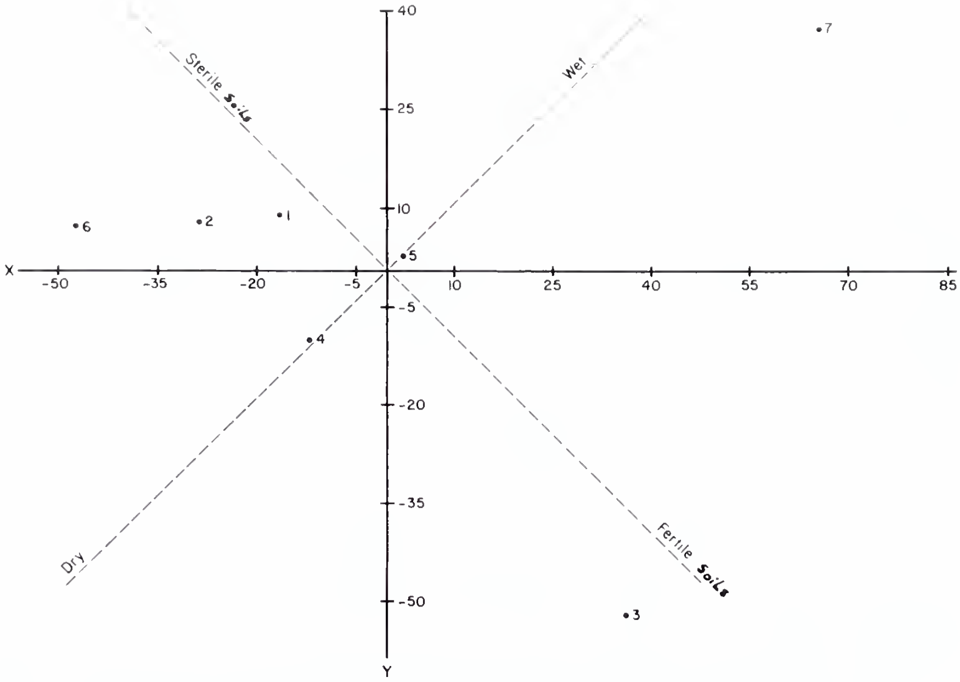

Fig. 3. Ordination of sample stands along axes oblique to conventional gradient axes.

to visualize the continuous relationships. It is apparent that soil moisture increases from lower left to upper right, while soil fertility increases from upper left to lower right. For example, the species populations found in stand six occur primarily on dry, sterile soils in the study area. The pattern of species dominance in stands two and one is found on soils not quite as dry and sterile as is the case for stand six. The pattern continues to stand seven, where the community characteristic of the most moist and fertile conditions in the sample is located.

CLASSIFICATION

A hierarchical classification of the seven sample stands in Cheek Bend is presented in Figure 4. Disturbances in Cheek Bend have produced a vegetation that is not representative of a steady-state or equilibrium (climax) condition. The first two or three species (by importance value ranking in each stand, with the possible exception of stand seven) consistently reflect a seral (successional) condition (Quarterman 1957).

Relying on the three species with the greatest importance values in each stand resulted in five clusters. The first cluster included stands one, two, and four. The dominant taxa are *Fraxinus americana* L., either *Carya ovata* (Miller) K. Koch and/or *Carya glabra* (Miller) Sweet, and *Juniperus virginiana.* The remaining stands each produced a different species importance value ranking: stand five—*Acer saccharum, Fraxinus americana,* and *Quercus velutina* Lam.; stand six—*J. virginiana, F. americana,* and *Quercus muehlenbergii*; stand three—*Cornus florida, Q. muehlenbergii,* and *Ostrya virginiana*; stand seven—*Acer saccharinum, Platanus occidentalis,* and *Fraxinus pennsylvanica.*

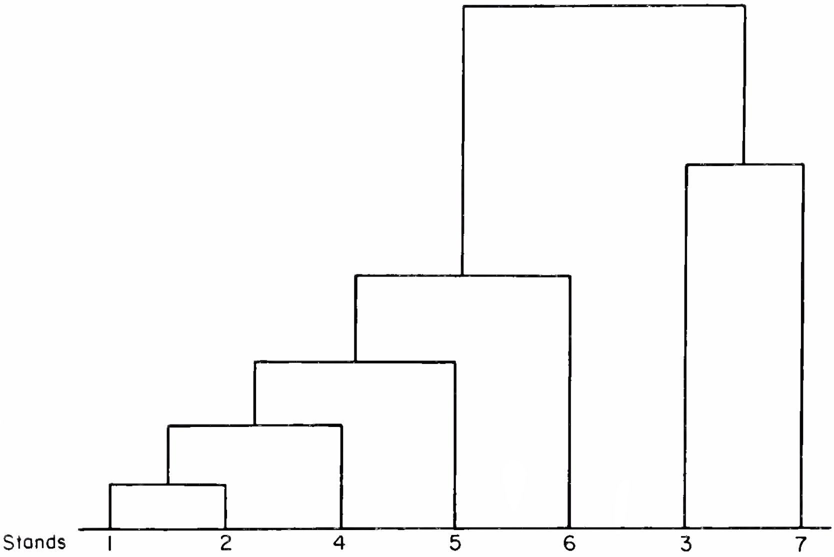

Fig. 4. Dendrogram of Cheek Bend sample cluster analysis of seven stands.

When all species represented in the stand clusters are considered, it becomes apparent that the high density of *Fraxinus americana* stems, a local successional species, is masking the importance value of oaks (*Quercus*) in Cheek Bend. Based upon diameter measurements it appears that the majority of stems of *F. americana* range from 5–30 years of age (see Fowells 1965: 193). Seedlings of *F. americana* are shade tolerant, being able to establish themselves in less than three percent of full sunlight. As age of the stems increases, however, there is a concomitant decrease in tolerance.

In each of the driest stands, *Fraxinus americana* was also one of the dominant species. However, the seedling/sapling strata were dominated by *Quercus muehlenbergii, Q. stellata* Wang., *Q. velutina,* and *Carya ovata.*

The following five communiities may be delineated: (1) *Carya-Juniperus-Quercus* (Stands 1, 2, and 4); (2) *Quercus-Acer saccharum-Fraxinus* (Stand 5); (3) *Juniperus-Quercus* (Stand 6); (4) *Quercus-Cornus florida-Ulmus* (Stand 3); (5) *Acer saccharinum-Platanus-Fraxinus pennsylvanica* (Stand 7).

The forest communities identified in Cheek Bend are congruent with different habitats identified by moisture conditions and topography. The *Carya-Juniperus-Quercus* community is associated with a sub-xeric upland habitat; the *Acer saccharum-Quercus-Fraxinus* community with a sub-mesic upland habitat; the *Juniperus-Quercus* community with a xeric upland habitat; the *Quercus-Cornus florida-Ulmus* community with a sub-mesic valley slope; and the *Acer saccharinum-Platanus-Fraxinus pennsylvanica* community with a mesic bottomland or floodplain habitat.

SUMMARY AND CONCLUSIONS

The primary objective of this pilot survey was to characterize the composition and distribution of forest communities in Cheek Bend. Virtually nothing was known of the relationships between forest communities and environmental gradients. The stratified random sampling procedure employed there allowed objective inferences to be made concerning vegetation-environmental gradients. Recognition of the influence of topography, soil moisture, and soil fertility gradients on vegetation in Cheek Bend will facilitate a more systematic sampling procedure in subsequent surveys.

The distinctive character of vegetation in the Nashville Basin was recognized at least 40 years ago. In fact, the vegetation patterns of the Basin have been considered virtually unique (Braun 1950). Ordination and classification of forest samples in Cheek Bend have provided some indication of the substantial diversity in forest composition which can be manifested in a small geographic area in the Nashville Basin. This realization makes it reasonable that a more extensive areal coverage be achieved and that an intensive sampling procedure be implemented.

ACKNOWLEDGEMENTS

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PRELIMINARY ANALYSES OF PLANT COMMUNITIES AND SEASONAL CHANGES IN CEDAR GLADES OF MIDDLE TENNESSEE

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ABSTRACT

The cedar glades of Middle Tennessee are a unique and threatened ecosystem within the State. Our study was conducted to provide preliminary quantitative data on community composition, seasonal floristic changes and edaphic distributions of cedar glade species and plant communities. We sampled 313 0.5 m^2 permanent plots on ten cedar glades in the Central Basin of Middle Tennessee in June and again in September–October of 1984. On each plot we recorded percent cover of each species and seven different ground-cover types, as well as soil depths and distance to edge of glade. Results presented focus upon changes from early to late summer in the frequency and cover of selected species. Seven cedar glade communities are discussed in relation to their species composition, soil depth, and ground-cover. Four of these types are placed in a xeric community class where soils average <5 cm deep; the other three with soils significantly deeper were grouped as a subxeric class.

INTRODUCTION

The cedar glades of the Central Basin in Middle Tennessee were recognized as a distinct natural community by some of the earliest botanists and geologists who explored the state (Safford 1869, 1884; Gattinger 1887, 1901). Knowledge about them has increased substantially since these early accounts. Floristic lists citing 344 herbaceous taxa for cedar glades in Tennessee, Alabama, and Georgia have been published (Baskin *et al.* 1968; Baskin and Baskin 1975). Of these taxa, approximately 25 are endemic or near-endemic to the cedar glades of the Southeast (Baskin and Baskin 1985). The high degree of endemism makes cedar glades the most botanically unique ecosystem in Tennessee.

Few studies of cedar glade communities in Middle Tennessee have been done. Harper (1926) wrote a brief description of cedar glades, and Picklesimer (1927) attempted to describe plant succession quantitatively on two of them in her thesis. Freeman (1933) published the first quantitative description of a cedar glade. Quarterman (1948, 1950a, 1950b) investigated 22 cedar glades to determine constancy and fidelity of glade species and to characterize the composition, structure, and successional trends of glade communities. During her tenure at Vanderbilt University, Quarterman stimulated several students to do further research on the cedar glades. Most of these investigations were autecological studies of endemic taxa. Baskin and Baskin (1977), former students of Quarterman, analyzed cedar glade communities dominated by *Schizachyrium scoparium* (Michx.) Nash.

The purposes of this study are to provide additional quantitative data on community composition, to assess seasonal floristic changes, and to determine edaphic distributions of cedar glade species and plant communities.

METHODS

Ten glades in Davidson, Maury, Rutherford, and Wilson counties were selected for sampling. Five of the glades were in public ownership and five in private ownership. Because floristic and vegetational composition and the rate of succession may vary depending on glade size (Skinner *et al.* 1983), we sampled glades of different sizes, from 0.15 ha (0.4 acre) to approximately 2.1 ha (5 acres). The average size was about 0.5 ha (1.2 acres).

Each glade was examined twice to detect seasonal variation in the plant communities. The early sampling period (summer) was between June 6 and July 5, 1984; the late (fall) was between September 17 and October 10, 1984. Plots were placed on a grid whose dimensions were 5 × 5 m, 10 × 10 m or 10 × 20 m, depending on the size of the glade. The first plot on each transect was at least 5 or 10 m from the glade edge. The start of each transect alternated from left to right side relative to the long axis of the glade so that neither edge would be precluded from sampling (Fig. 1). We attempted to sample 30 plots/glade. The number of plots per glade ranged from 22–45 ($\mu = 31$ plots).

A 0.5 m^2 sampling frame delimited each plot. Two diagonal corners of each plot were marked with spray-painted nails that were tagged with flagging tape and shoved into the substrate. Where bedrock prevented this, corners were marked with stacks of flagstones. At each plot the total vegetation cover and percent cover of each identified taxon were estimated. Except for the most abundant moss, *Pleurochaete squarrosa* (Brid.) Lindb., the most common blue-green alga, *Nostoc commune* Vauch., and the most common genus of lichen, *Cladonia*, the nonvascular plants were treated categorically as either "bryophyte" or "lichen." In cases of overlapping vegetation cover, only the uppermost layer was counted. When a difference between the total overall cover and the sum of the individual species percentages occurred, adjustments were made by the evaluators until the two totals agreed.

The percent cover of various ground-cover types was estimated for each plot. Ground-cover was interpreted as either bedrock, flagstone, gravel, soil, organic litter, bryophytes, lichen, or *Nostoc*. Because the nonvascular plants covered large areas in some glades, they were treated as ground-cover types in addition to the physical substrates. Flagstone was defined as any loose piece of limestone occu-

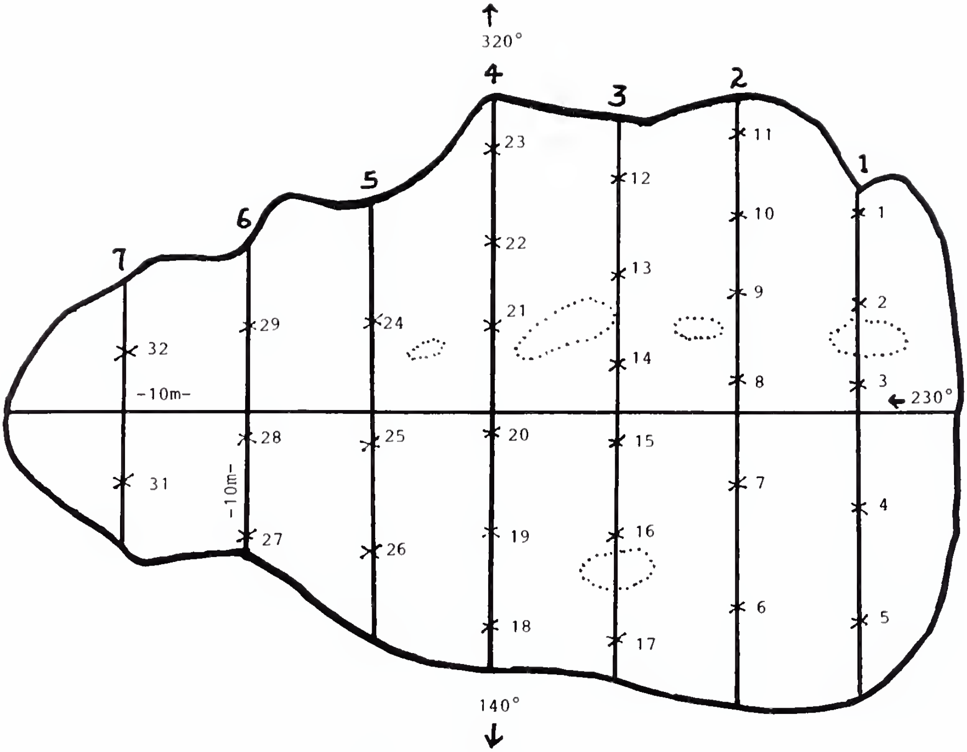

Fig. 1. Placement of transects and plots on a cedar glade.

pying greater than 10 × 10 cm. We suspected that the influence of litter on determining the type of vegetation might be secondary to the influence of the underlying ground-cover, therefore, two methods were used to estimate percent cover. In the first evaluation litter was treated as a ground-cover type; in the second it was not. The latter was relied upon for the analysis of data presented here.

Nine soil depth measurements were taken at each plot. The distance from each plot to the edge of the glade, or to an island of vegetation considered large enough to shade the plot, was measured by pacing to the outer branches of the nearest tree or shrub. The distance was recorded to the nearest 0.5 m.

The procedure CLUSTER of the Statistical Analysis System (SAS Institute Inc. 1982) was used to determine relationship of species composition among plots and to identify communities by grouping similar plots. CLUSTER is an iterative, agglomerative, hierarchical technique.

The analysis was run for eight clusters using the data for all taxa that occurred on at least 30 plots (early and late samples combined). This yielded 37 taxa for which percent cover statistics (arcsin transformed values) were summarized for each cluster. The higher of the early or late cover values for each taxon on a plot was utilized in the cluster analysis. Summaries of soil depth, ground-cover characteristics, and total cover were produced for each cluster. After examining the results of these analyses, we judged that seven clusters best represented the true communities of the limestone cedar glades sampled. With the exception of the high importance of *Rudbeckia triloba* L., two of the clusters were very similar in species composition and importance and, therefore, were merged.

Table 1. Taxa with greater than 20% frequency in early or late samples on 10 cedar glades in Middle Tennessee.

	No. of glades		Frequency		Cover	
Taxon	Early	Late	Early	Late	Early	Late
Sporobolus vaginiflorus	10	10	0.80	0.86	0.09	0.18
Dalea gattingeri	10	10	0.74	0.68	0.14	0.09
Nostoc commune	10	9	0.51	0.52	0.05	0.05
Isanthus brachiatus	10	10	0.40	0.38	0.04	0.05
Erigeron strigosus	10	10	0.40	0.42	0.03	0.03
Heliotropium tenellum	10	10	0.38	0.39	0.03	0.04
Ruellia humilus	10	10	0.38	0.37	0.05	0.04
Pleurochaete squarrosa	10	10	0.34	0.41	0.06	0.07
Arenaria patula (dead)	8	8	0.27	0.18	0.02	0.01
Croton capitatus	9	10	0.27	0.30	0.02	0.02
lichen (not *Cladonia*)	9	6	0.25	0.25	0.04	0.04
Senecio anonymus	10	10	0.23	0.15	0.02	0.01
Leavenworthia stylosa	8	4	0.22	0.03	0.01	0.01
Panicum capillare	10	9	0.21	0.28	0.01	0.04
Scutellaria parvula	8	3	0.21	0.02	0.01	0.01
Hypericum sphaerocarpum	9	9	0.21	0.21	0.02	0.02
Croton monanthogynus	9	10	0.16	0.26	0.01	0.02
Panicum flexile	9	10	0.14	0.28	0.01	0.04
Total					0.66	0.77

RESULTS

In the 313 sampled plots a total of 132 plant taxa were identified. These taxa included representatives of 47 vascular plant families. The predominant ones were Poaceae (15 taxa), Asteraceae (16 taxa), Fabaceae (8 taxa), and Euphorbiaceae (7 taxa). Taxa not previously reported by Baskin *et al.* (1968) or Baskin and Baskin (1975) that we encountered were *Coreopsis tripteris* L., *Juncus filipendulus* Buckley, and *Sporobolus asper* (Michx.) Kunth.

Gravel and plant litter had the highest cover values on our plots. Bedrock represented only 3 percent of the average ground-cover. Mean soil depth was 5.3 ± 0.18 cm; mean maximum and minimum soil depths were 9.2 ± 0.28 cm and 1.74 ± 0.13 cm, respectively.

Seasonal Vegetation Change

We observed 130 taxa in the summer (early) sample and 121 taxa in the fall (late) sample. Eighteen taxa occurred with a frequency greater than 20% of the plots in one or both sampling periods. These plants (Table 1) accounted for 66% of the total summer and 77% of total fall vegetation cover. *Sporobolus vaginiflorus* (Torr.) Wood was the most frequently encountered species in both samples and had the highest cover of any species in our fall sample. This species increased in both frequency and cover from the summer to fall sample. *Croton monanthogynus* Michx., *Panicum capillare* L., and *P. flexile* (Gattinger) Scribn., three summer annuals, also increased in frequency and cover from summer to fall. *Dalea gattingeri* (Heller) Barneby had the highest cover of any species in our summer sample. *Nostoc commune* occurred on 59% of the summer and fall plots, but it

Table 2. Endemic taxa in early and late samples from 10 cedar glades in Middle Tennessee.

Taxon	Number of glades	Frequency in 313 plots	
		Early	Late
Astragalus tennesseensis	4	3	3
Dalea gattingeri	10	233	213
Echinacea tennesseensis	3	8	8
Leavenworthia exigua (dead)	2	26	4
Leavenworthia stylosa (dead)	8	69	10
Leavenworthia torulosa (dead)	2	13	2
Lobelia appendiculata var. *gattingeri*	6	25	2
Onosmodium molle var. *molle*	1	4	3
Oxalis priceae ssp. *priceae*	1	1	1
Psoralea subacaulis	7	40	0
Talinum calcaricum	4	28	21
Viola egglestonii	4	8	5
% of total sample			

* Significantly different from the mean ($P = 0.05$).

had a relatively low cover (5%) in both sampling periods. *Arenaria patula* Michx. and *Leavenworthia stylosa* Gray, conspicuous members of the spring glade community, had low cover in the summer and fall samples.

Of all taxa encountered, the cover of 14 species more than doubled between the summer and fall samples. Twenty-four species increased 10% to 90% in cover, 19 species did not show a change in cover, 48 species decreased 10% to 90% in cover, and 23 species disappeared from summer to fall season. Among those species that more than doubled in cover during the summer growing season were the forbs, *Croton monanthogynus, Euphorbia maculata* L., *Euphorbia supina* Raf., *Galium* sp., *Gutierrezia dracunculoides* (DC.) Blake, *Hedyotis nigricans* (Lam.) Fosberg, and *Linum sulcatum* Riddell; and six grasses, *Aristida longespica* Poir., *Eragrostis capillaris* (L.) Nees, *Panicum capillare, P. flexile, Panicum lanuginosum* Ell., and *Sporobolus vaginiflorus.*

We found 12 endemic species (Baskin and Baskin 1985) within our plots in either the summer or fall sample (Table 2). These endemic species accounted for 20% of the total early summer vegetation cover and 12.5% of the total fall vegetation cover. *Dalea gattingeri,* a perennial species which is prevalent on the glades from spring to fall, accounted for the majority of the plant cover contributed by the endemics. This species accounted for 14.5% of the summer and 9% of the total fall vegetation cover. Of other endemics encountered, only *Psoralea subacaulis* T & G contributed more than one percent to the total cover in either the summer or fall sample. *Psoralea* was present in the summer on seven glades in 40 plots, but no individuals of this perennial species were detected within our plots in the fall sample. The species of *Leavenworthia,* which can be very abundant

Table 2. Extended.

Mean cover (%)		Mean distance to edge (m)	Soil depth (cm)		Primary ground-cover (avg. for plots with this taxon)
Early	Late		Min.	Max.	
<0.1	<0.1	3.8	2.8	9.0	Litter 49% Gravel 24%
14.5	9.2	4.0	1.6	8.8	Gravel 52%
0.5	0.5	2.5	1.2	8.6	Litter 17%
0.4	0.1	3.9	1.2	6.3*	Gravel 48% Bare soil 24%
0.9	0.5	4.4*	1.1	7.8*	Gravel 40% Litter 20%
0.2	<0.1	2.1*	1.6	7.6	Gravel 35% Litter 24%
0.3	0.1	4.8	2.6	12.4*	Gravel 30% Litter 26%
0.4	0.2	2.2	1.2	10.4	Gravel 65%
0.5	0.2	7.0	4.0	20.0	Litter 99%
1.4	0.0	3.0*	1.3	8.3	Gravel 49% Litter 17%
0.5	1.1	3.9	0.6*	5.2*	Gravel 37% Litter 12% Bare soil 12%
0.3	0.4	0.9*	3.0	13.7	Litter 37% Moss 19%
20.0	12.5				

on the glades during March and April, were encountered only as dead individuals during both sampling periods.

Other than *D. gattingeri,* the endemic species, which were sampled in more than 10 plots in either the summer or fall sample, demonstrated significant differences ($P = 0.05$) as compared to the means for soil depths or distance of the plots to the edge of the cedar glade (Table 2). *Talinum calcaricum* Ware, *Leavenworthia stylosa,* and *L. exigua* Rollins were growing in soils which were significantly shallower than those of the average plot. *Viola egglestonii* Brainerd, *P. subacaulis,* and *Leavenworthia torulosa* Gray were encountered in plots which were significantly closer to the edge of the glade than the average plot.

We compared the mean ground-cover and soil depth measurements from the plots on which selected species occurred versus the plots on which those species were absent. The species investigated include *Leavenworthia stylosa, Sporobolus vaginiflorus, Croton capitatus* Michx., *Talinum calcaricum, Echinacea tennesseensis* (Beadle) Small, and *Dalea gattingeri.* Respectively, these represent a winter annual, two summer annuals, two summer active perennials, and a perennial which is actively growing from spring to fall.

Dalea gattingeri was encountered on 77% of the sample plots. These plots were closer to the edge of the glade, soils were deeper; bedrock, soil, and moss cover were less; and gravel cover was greater than on those plots where the species was absent.

Sporobolus vaginiflorus occurred with a frequency of 90% during the summer and/or fall sampling period. This species occurred on plots with lower percent cover of bare soil and moss, and greater percent cover of plant litter, gravel, and

Table 3. Cover and frequency percentages for 37 most frequent taxa and mean vegetation cover for all taxa in 7 communities on 10 cedar glades in Middle Tennessee.

	COM1 %		COM2 %	
Taxon	Cover	Freq	Cover	Freq
Allium cernuum	—	—	<1	5
Arenaria patula	4	91	1	50
Aristida longespica	—	—	<1	5
Carex crawei	<1	10	—	—
Cladonia spp.	<1	18	1	35
Croton capitatus	<1	27	<1	10
Croton monanthogynus	<1	10	<1	30
Dalea gattingeri	1	73	5	85
Diodia teres	—	—	<1	5
Erigeron strigosus	2	82	2	70
Euphorbia dentata	—	—	<1	50
Hedyotis nigricans	—	—	—	—
Heliotropium tenellum	<1	10	1	50
Hypericum sphaerocarpum	<1	27	<1	20
Isanthus brachiatus	<1	18	1	30
Juniperus virginiana	—	—	—	—
Leavenworthia exigua	<1	27	<1	15
Leavenworthia stylosa	1	64	<1	35
Leucospora multifida	—	—	<1	10
Lichen (foliose spp.)	1	54	33	100
Manfreda virginica	—	—	<1	20
Nostoc commune	1	64	<1	40
Nothoscordum bivalve	<1	36	<1	5
Panicum capillare	15	91	1	60
Panicum flexile	<1	10	1	25
Pleurochaete squarrosa	6	82	1	55
Psoralea subacaulis	—	—	—	—
Rudbeckia triloba	1	27	<1	10
Ruellia humilis	<1	10	<1	10
Satureja glabella	<1	27	<1	5
Schizachyrium scoparium	—	—	—	—
Scutellaria parvula	1	54	<1	50
Sedum pulchellum	3	100	1	35
Senecio anonymus	<1	36	1	45
Sporobolus vaginiflorus	2	64	3	85
Talinum calcaricum	1	73	<1	20
Verbena simplex	<1	10	1	25
Mean vegetation cover for all taxa	48		67	

flagstone than on those plots where it was not present. Where *S. vaginiflorus* occurred, soil depths averaged 5.4 cm ± 0.02 with an average maximum depth of 9.3 cm ± 0.03.

Leavenworthia stylosa was not actively growing during the period of this study; the species was observed only as dead individuals with a frequency of 23%. The plots in which this species occurred had shallower soils and were farther from the edge of the glade than plots in which it did not occur. Where *L. stylosa* occurred, bare soil and moss ground-cover were less, while gravel and flagstone cover were greater, than in those plots where it was absent.

Table 3. Extended.

COM3 %		COM4 %		COM5 %		COM6 %		COM7 %	
Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq
1	17	<1	3	<1	6	<1	4	<1	3
<1	38	<1	16	<1	24	<1	16	<1	20
<1	5	<1	3	<1	11	<1	12	<1	7
<1	2	<1	3	<1	11	1	16	2	43
<1	2	<1	1	<1	4	1	32	2	43
<1	17	<1	24	1	60	1	28	<1	57
<1	16	<1	20	<1	28	1	64	<1	33
1	63	19	100	6	88	2	44	<1	43
<1	5	<1	11	<1	7	<1	24	<1	20
1	56	<1	42	1	50	1	48	<1	43
<1	10	<1	38	<1	18	<1	60	<1	33
1	21	<1	1	<1	4	<1	8	<1	10
1	37	1	51	1	46	<1	32	2	57
<1	12	<1	17	1	36	<1	20	1	47
1	42	3	66	1	50	<1	20	<1	17
<1	10	<1	3	<1	3	1	28	<1	13
<1	18	<1	3	<1	4	—	—	—	—
<1	20	<1	25	<1	14	<1	16	<1	23
<1	10	<1	8	<1	9	—	—	<1	3
<1	21	<1	24	1	27	—	—	<1	23
<1	9	<1	18	<1	23	1	28	<1	30
3	80	1	61	1	70	<1	12	<1	17
<1	5	<1	6	<1	16	<1	12	<1	17
<1	33	<1	28	<1	26	<1	4	<1	7
<1	17	<1	13	<1	20	5	96	3	63
<1	26	<1	19	1	47	42	100	3	73
<1	13	<1	14	<1	17	<1	25	<1	3
<1	2	<1	3	<1	4	<1	4	<1	23
<1	17	1	51	1	53	3	72	2	70
<1	10	<1	3	<1	9	<1	36	<1	30
<1	6	<1	3	<1	9	<1	12	1	27
<1	6	<1	17	<1	23	<1	12	<1	43
<1	30	<1	3	<1	7	<1	8	—	—
<1	12	<1	10	<1	21	1	56	<1	57
3	84	7	98	30	100	2	68	5	83
<1	18	<1	2	<1	4	<1	4	—	—
<1	17	<1	13	<1	14	<1	40	<1	17
21		37		47		86		61	

Echinacea tennesseensis, a federally endangered species, occurred with a frequency of 2.5% and only at three glades that were deliberately included in the study because of its presence. These plots were farther from the edge of the glade, and higher in gravel cover than those plots where it did not occur. This species was encountered on plots which had less moss, plant litter, and bare soil than on plots where it was absent.

On the 32 plots (frequency = 10%) where *Talinum calcaricum* occurred, there was less moss, plant litter, bare soil and exposed bedrock, and soils were shallower, than on plots where it was absent.

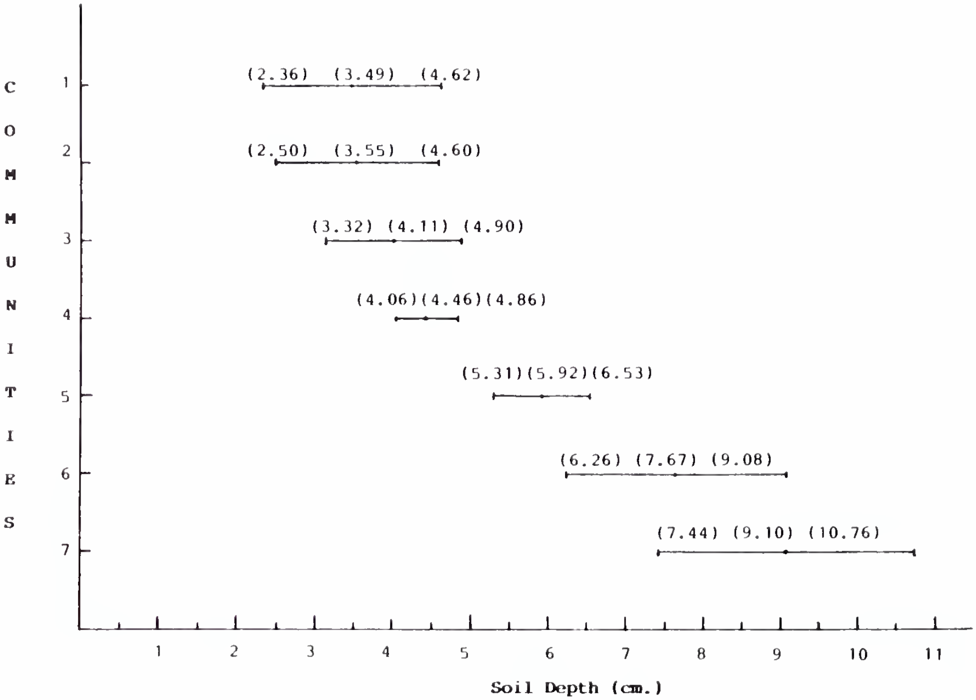

Fig. 2. Means and 95% confidence intervals for 7 cedar glade communities in Middle Tennessee.

Croton capitatus occurred with a frequency of 33%. Plots where it was present had shallower soils, less moss cover, less bare soil, and less bedrock cover than plots without the species. The percent cover of both gravel and flagstone was greater on plots where *C. capitatus* was present than on plots where it was absent.

Limestone Cedar Glade Communities

Our cluster analysis procedure combined data from the two sample periods, utilizing the highest of the two cover percent values per plot. By using this approach, we incorporated the seasonal dynamics of phenological changes into our analysis.

The results of our cluster analysis (Table 3) and subsequent ranking of these vegetation clusters by mean soil depth (Fig. 2) suggest that there are two broad classes of glade communities. One type, here called the xeric class (communities 1–4), has soils which are less than 5 cm deep; the other occurs on significantly deeper soils ($P = 0.05$) than the subxeric class (communities 5–7). Each of the seven communities described below was named for the dominant taxon or taxa which together contributed up to 50% of the total community percent cover.

A. Xeric Communities

1. *Panicum capillare Community:* Annual grasses and forbs plus glade-moss dominate this community. *Panicum capillare* is the dominant species with 15% cover, and *Pleurochaete squarrosa* ranks second with 6%. *Arenaria patula* and *Sedum pulchellum* Michx. are very frequent but low in cover during the summer and fall. *Erigeron strigosus* Muhl., *Nostoc commune*, and foliose lichens are im-

portant components as well. Other taxa that achieve their highest frequency in this community are *Nothoscordum bivalve* (L.) Britt. and *Scutellaria parvula* Michx.

Three cedar glade endemics, two *Leavenworthia* species (usually either *L. stylosa* or *L. exigua* present) and *Talinum calcaricum* have their highest frequency in this community. Also, *Isoetes butleri* Engelm., *Lobelia appendiculata* var. *gattingeri* (A. Gray) Michx., and *Satureja glabella* (Michx.) Briq. are locally abundant in the spring.

This community has a frequency of 4% and a presence of 20%. These plots contain more flagstone than those in any of the other communities sampled. Also, the average soil depth (3.5 ± 1.7 cm) measured in this community is the lowest recorded among the glade communities. The percentages of soil and gravel cover are relatively high in these plots, while those of bedrock, lichen, and litter are relatively low.

2. *Foliose lichen Community:* This community is dominated by foliose lichens, which contribute about half of the total vegetation cover of 67%. The perennial *Dalea gattingeri,* a cedar glade endemic, and *Sporobolus vaginiflorus* are the dominant herbs. *Arenaria patula, Erigeron strigosus, Senecio anonymus,* and *Panicum capillare* have relatively high frequencies and contribute a minor amount (1–2%) to the cover. *Euphorbia dentata* Michx. and *Scutellaria parvula* are relatively frequent. *Leucospora multifida* (Michx.) Nutt., an annual often found on mud or sand of stream banks and lakeshores, occurs here as diminutive plants occupying cracks in the limestone bedrock.

The endemic glade-cresses, *Leavenworthia stylosa, L. exigua,* and *L. torulosa,* are all present in the spring. *Leavenworthia stylosa* has its highest frequency in this community, and *Talinum calcaricum* has its second highest frequency here.

This community has a frequency of 6% and a presence of 50%. Besides the obvious importance of lichens (foliose and *Cladonia* spp.) as ground-cover, bedrock and gravel also have relatively high coverage here. Mean soil depth is 3.6 ± 2.2 cm, similar to that of the previous community. Soil, moss and *Nostoc* are minor components of the ground-cover in these plots.

3. *Nostoc commune—Sporobolus vaginiflorus Community:* This community is dominated by *Sporobolus vaginiflorus* and *Nostoc commune,* but the percent coverage for each is very low, averaging only about 3%. *Nostoc* cover is probably greatest during late winter and early spring when low areas and slight depressions on the glades are often covered with standing water. *Nostoc* is usually dry and shriveled at other seasons, unless it has recently rained. *Sedum pulchellum* and *Arenaria patula* are frequently associated with *Nostoc* at these seasonally wet areas in the spring. The relatively frequent *Dalea gattingeri, Isanthus brachiatus* (L.) BSP., *Panicum capillare, Erigeron strigosus,* and *Heliotropium tenellum* (Nutt.) Torr. are more conspicuous during the late summer/fall period, when *S. vaginiflorus* dominates the community.

Other glade endemics besides *Dalea gattingeri* that are associated with this community are *Leavenworthia exigua, L. stylosa, L. torulosa, Echinacea tennesseensis, Talinum calcaricum, Onosmodium molle* var. *molle* Michx., and *Psoralea subacaulis.* Also, *Evolvulus pilosus,* a rare disjunct from the Midwest, occurs here.

This community has a frequency of 24% and a presence of 100%. The mean soil depth is 4.1 ± 3.4 cm, slightly, but not significantly, deeper than in the previous two communities. This community is characterized by an abundance of gravel, and has the highest percentage of surface bedrock. *Nostoc,* flagstone, and bedrock are nearly equal as ground-cover types here. Litter cover is less than in any other community.

4. *Dalea gattingeri Community: Dalea gattingeri* is the dominant in this community with approximately 19% cover; *Sporobolus vaginiflorus* and *Isanthus brachiatus* are of secondary importance. The summer annual, *Isanthus brachiatus,* is conspicuous in the autumn. Species that are relatively frequent but contribute little cover in this community are *Ruellia humilis* Nutt., *Nostoc commune, Erigeron strigosus, Euphorbia dentata, Croton monanthogynus, Croton capitatus,* and *Heliotropium tenellum.*

The endemic *Psoralea subacaulis,* a stout-rooted perennial, is a spring and early summer constituent of this community, but above ground evidence of it essentially disappears by autumn. *Echinacea tennesseensis* and *Lobelia appendiculata* var. *gattingeri* are sometimes found in this community, as are several other taxa on Tennessee's list of rare plants, such as *Evolvulus pilosus* and *Schoenolirion croceum* Gray.

This community has a frequency of 26% and a presence of 100%. The soils are not significantly deeper, 4.5 ± 1.8 cm, than in the previously described communities. The major ground-cover type is gravel, which tends to be more prevalent here than in other glade communities. Flagstone and *Nostoc* also have relatively high percent cover values.

B. Subxeric Communities

5. *Sporobolus vaginiflorus Community:* The annual grass *Sporobolus vaginiflorus* dominates this community with about 30% coverage; *Dalea gattingeri* (6%) is secondary to it. Species with relatively high frequencies and contributing about 1% cover are *Ruellia humilis, Nostoc commune, Heliotropium tenellum, Isanthus brachiatus, Croton capitatus, Erigeron strigosus,* and *Hypericum sphaerocarpum* Michx. A few plants of *Manfreda virginica* (L.) Salisb. ex Rose, *Aristida longespica,* and foliose lichens typically occur in this community.

In the spring, this is the community where the cedar glade endemics *Psoralea subacaulis* and *Lobelia appendiculata* var. *gattingeri* and two Tennessee rarities, *Schoenolirion croceum* and *Isoetes butleri,* are often abundant. The cedar glade endemics, *Echinacea tennesseensis, Astragalus tennesseensis* Gray, and *Viola egglestonii,* occur infrequently in this community.

This community has a frequency of 22% and a presence of 100%. The soil, 5.9 ± 2.6 cm deep, is significantly deeper ($P = 0.05$) than in the previously described communities. Gravel is the major ground-cover type in this community, but soil and litter are more abundant than in the *Dalea gattingeri* community. Occasional flagstones make up a small component of ground-cover.

6. *Pleurochaete squarrosa Community:* This community has the highest vegetation cover (86%) of any seen. *Pleurochaete squarrosa,* averaging 42% cover, is the dominant plant species. The major coverage by vascular plants comes from *Panicum flexile* (5%) and *Ruellia humilis* (3%) and the following taxa which contribute approximately 1–2% cover: *Sporobolus vaginiflorus, Dalea gattingeri, Erigeron strigosus, Cladonia* spp., small *Juniperus virginiana* L., *Ambrosia artemisiifolia* L., *Carex crawei* Desr., *Croton monanthogynus, C. capitatus, Senecio anonymus,* and *Manfreda virginica. Euphorbia dentata, Verbena simplex* Lehm., and *Satureja glabella* achieve their highest frequencies here.

Although *Psoralea subacaulis* is a conspicuous member of this community in the spring, it contributes essentially no cover during the summer or fall. The rare endemics *Viola egglestonii, Echinacea tennesseensis,* and *Astragalus tennesseensis* infrequently occur here. Only one plot within this type contained *E. tennesseensis* plants, but they were very dense (57% cover) over the *Pleurochaete squarrosa*-dominated ground-cover in the plot. Another rare taxon that sometimes occurs here is *Phlox bifida* ssp. *stellaria* (Gray) Wherry.

The community has a frequency of 8% and a presence of 70%. It is most frequent on the three glades with populations of *Echinacea tennesseensis.* The mean soil depth, 7.7 ± 3.4 cm, is significantly greater ($P = 0.05$) than that on all of the communities in the xeric group, but not from the others in the subxeric group. The ground-cover is dominated by *Pleurochaete squarrosa.* Soil, gravel, and lichens are secondary components; *Nostoc* and bedrock seldom occur here.

7. *Panicum flexile—Pleurochaete squarrosa—Sporobolus vaginiflorus Community:* This community has 61% vegetation cover, relatively high species richness, and is often found near the edge of open glades. It is similar to the previous community, but *Pleurochaete squarrosa* is not the only dominant. Besides *P. squarrosa,* two annual grasses, *Sporobolus vaginiflorus* and *Panicum flexile,* one perennial grass, *Schizachyrium scoparium,* a sedge, *Carex crawei, Ruellia humilis, Heliotropium tenellum* and *Cladonia* spp. have the highest cover values (2–5%). Occasionally, colonies of *Rudbeckia triloba* dominate parts of this community. Other taxa with frequent occurrence in this type are *Erigeron strigosus, Hypericum sphaerocarpum, Diodia teres* Walt., *Manfreda virginica, Senecio anonymus, Scutellaria parvula, Satureja glabella, Croton capitatus,* and *C. monanthogynus.*

Several glade endemics, such as *Oxalis priceae* Small ssp. *priceae* and others listed for the previous community, may occur here, but none was recorded frequently. The same is true for a number of other rare taxa that are confined primarily to cedar glades.

This community has a frequency of 10% and a presence of 90%. The mean soil depth, 9.1 ± 4.1 cm, is the highest for any of the communities identified. This is significantly higher than those of all other glade communities, except the *Pleurochaete squarrosa* community. The most notable feature of ground-cover is the abundance of litter, which is most frequently found covering soil, gravel, bryophytes or lichen. Some flagstone occurs here, but exposed bedrock is almost absent.

DISCUSSION

The main objectives in this study were to investigate how individual species presence and abundance vary from one season to the next, and how species are distributed on the cedar glades of Middle Tennessee. We found 132 plant taxa, including 12 endemics, which represent approximately one-third of the total southeastern glade flora and nearly half of the endemics (Baskin and Baskin 1985).

Sporobolus vaginiflorus was the most frequently encountered species in our plots and had the greatest species cover in the late sample. Baskin and Baskin (1985) list this species as the most important species in glade communities on soils of 5–25 cm in depth. *Dalea gattingeri* had the highest cover of any taxon in our early sample plots.

The timing of our sampling resulted in low frequency and cover for the winter annuals of the glades, *e.g. Leavenworthia* spp., *Arenaria patula, Sedum pulchel-*

lum, and *Psoralea subacaulis.* These conspicuous spring plants on the cedar glades (Quarterman 1950b, 1973) become dormant as the soil dries out. Summer annual forbs and grasses increased most in cover from the early to the late sample period.

Only two endemics occurred on more than half of the glades, *Dalea gattingeri* and *Leavenworthia stylosa.* The remaining endemic species were rarely encountered in the plots and exhibited low cover values when present. All endemics, save three, decreased in frequency as the summer progressed; *Oxalis priceae* ssp. *priceae* was encountered with the same frequency in the early and late samples. Both *Talinum calcaricum* and *Viola egglestonii* increased in cover from summer to fall.

Freeman (1933) described communities in terms of the "aspect societies" visible at two different times (May and August) on a glade. Unfortunately, he did not use an unbiased approach to select plots. The classic study by Quarterman (1950b), on the other hand, employed a systematic method for locating plots. Her data, gathered during the summer (June–August), led to the recognition of two basic community types: gravel and grass glades. The former are described as areas with soils up to 7.6 cm deep and the latter as those with soils 7.6–15.2 cm deep. A refinement of this (Quarterman 1973) delimited areas with soil from zero to 5 cm deep as Zone I and those with soil from 5–20 cm deep as Zone II. The xeric and subxeric community classes summarized in Table 4 are similar to Quarterman's Zone I and II community types. Our analyses confirmed her conclusion that the division between the more xeric communities (Zone I or gravel glades) and the subxeric ones (Zone II or grass glades) may be sharply defined at a mean soil depth of about 5 cm. Our results showed a significant difference in soil depth between the *Dalea gattingeri* community ($\mu = 4.5 \pm 1.8$ cm) and the *Sporobolus vaginiflorus* community ($\mu = 5.9 \pm 2.6$ cm). *Dalea gattingeri* cover was much greater in the former (19% vs 6%) and cover by *Sporobolus vaginiflorus* was much greater in the latter (30% vs 7%).

Our results agreed closely with Quarterman's (1950b) regarding the dominance of *Sporobolus vaginiflorus, Dalea gattingeri, Nostoc commune, Pleurochaete squarrosa,* and other taxa in cedar glade communities. On the other hand, a few taxa described by Quarterman (1973) as seasonal dominants, were infrequent in our plots. For instance, two species she described as summer dominants occurring sporadically in Zone I, *Talinum calcaricum* and *Cyperus inflexus* Muhl. (=*C. aristatus* Rottb.), had frequencies of 10% and <1%, respectively. Also, the importance of *Aristida longespica* (frequency = 7%) as a co-dominant with *Sporobolus vaginiflorus* (frequency = 90%) in Zone II is not supported.

In this study, 73% of the plots were assigned to one of the three community types with soils averaging between 4 to 6 cm deep (communities #3, #4, & #5). These were also the only communities that occurred in all ten glades sampled. The *Nostoc commune*-dominated community (#3), with a mean soil depth less than the other two, had the lowest mean vegetation cover (21%) of all the communities. The other common communities were the ones dominated by either *Dalea gattingeri* or *Sporobolus vaginiflorus.* In both of these, the vegetation cover was low, averaging 37 and 47% respectively, and the dominant taxon in each contributed more than half the total cover.

The greatest vegetation cover (86%) was in community #6 where there were large mats of *Pleurochaete squarrosa* on soils 6 to 9 cm deep. The community with the next highest cover was the one dominated by foliose lichens (#2) on

Table 4. Data summary for plant communities on 10 cedar glades in Middle Tennessee.

Community	Mean soil depth ± S.D. (cm)	Dominant ground-cover	Number		
			Glades	Plots	Taxa
A. Xeric Class					
1. *Panicum capillare*	3.5 ± 1.7	Soil, gravel, flagstone	2	11	45
2. *Foliose lichen*	3.6 ± 2.2	Lichen, bedrock, gravel	5	20	63
3. *Nostoc commune—Sporobolus vaginiflorus*	4.1 ± 3.4	Gravel, bedrock	10	76	97
4. *Dalea gattingeri*	4.5 ± 1.8	Gravel	10	83	73
B. Subxeric Class					
5. *Sporobolus vaginiflorus*	5.9 ± 2.6	Gravel, soil, litter	10	70	76
6. *Pleurochaete squarrosa*	7.7 ± 3.4	Moss, soil, gravel, lichen	7	25	96
7. *Panicum flexile—Pleurochaete squarrosa—Sporobolus vaginiflorus*	9.1 ± 4.1	Litter, soil, moss, lichen	9	30	101

shallow soils ($\mu = 3.5$ cm). Bryophytes, lichens or *Nostoc* were the leading dominant in three of the seven communities and of secondary importance in two others. These data demonstrate the importance of non-vascular plants on the cedar glades.

A majority of 37 most frequent taxa studied were found at least occasionally in all communities. Only a few taxa; *e.g. Psoralea subacaulis, Juniperus virginiana,* and *Schizachyrium scoparium*; were not present in communities #1 and #2 where soils were the thinnest. *Schizachyrium scoparium* achieved its highest frequency (28%) in Community #7. Dense tussocks of this perennial grass occurred on half of the plots on one Wilson County glade. None of the glades sampled, however, had *S. scoparium* at the high (99%) frequency observed on the six sites sampled by Baskin and Baskin (1977).

Except for *Dalea gattingeri,* rare and/or endemic taxa were encountered so infrequently that we can reach no firm conclusions about their primary habitats on the cedar glades. *Echinacea tennesseensis,* for instance, was found on only nine plots, representing communities #3, #4, #5, and #6. Thus, the fidelity of endemics to community types or classes cannot be substantiated by our data. *Talinum calcaricum,* encountered in 32 plots, may be an exception since 81% of the time it occurred in the xeric community class.

The communities described here may be criticized as artificial because they represent the synthesis of data from two points in time. They do, however, have the advantage of representing two seasons instead of only one. We have chosen to combine the data in order to best characterize the types of glade communities. Sampling in the early spring, when a number of ephemeral glade species flourish, needs to be accomplished in order to better describe these communities and seasonal dynamics of the cedar glade flora. We expect clarification of the relationship between these communities and physical parameters of the glade environment to come from further analyses. Such examinations were, unfortunately, beyond the scope of the present effort.

ACKNOWLEDGEMENTS

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LIFE HISTORY STRATEGY OF THE HIGHLY ENDEMIC CEDAR GLADE SPECIES *ECHINACEA TENNESSEENSIS*

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ABSTRACT

Echinacea tennesseensis (Beadle) Small is a highly endemic species restricted to the grassy zone of certain cedar glades of middle Tennessee. Autecological studies were performed to assess its status as a component of the cedar glade ecosystem; included were seed germination, competition, and allelopathy experiments. Among possible explanations for the narrow endemism of this species are low competitive ability and inability of its seeds to be dispersed from one open cedar glade to others nearby.

INTRODUCTION

The importance of autecological studies in understanding endemism and the position occupied by endemics in their respective ecosystems has been stressed by many plant ecologists. Among the cedar glade species which have been studied in this manner (Baskin and Baskin 1982; Hemmerly 1976) is *Echinacea tennesseensis,* the Tennessee coneflower, a herbaceous perennial of the Compositae.

Dr. A. Gattinger first collected the plant in 1878 at La Vergne (Rutherford County), Tennessee, and it was found in that vicinity as recently as 1967 (Dr. R. Kral, pers. comm., 1970). However, McGregor (1968) was unable to locate any *Echinacea* plants at the site, and, therefore, in his monograph of the genus he considered the species to be probably extinct.

The present study was initiated in response to the discovery of two populations of *E. tennesseensis* in middle Tennessee. The first population occurs in an open cedar glade in Davidson County, Tennessee (Baskin *et al.* 1968) and the second in open glades in and near Cedars of Lebanon State Forest, Wilson County, Tennessee (Quarterman and Hemmerly 1971). Since then, two additional natural populations have been discovered in cedar glades of middle Tennessee. The Tennessee coneflower is one of two plant taxa native to the state on the U.S. Fish and Wildlife Service's official list of endangered species (USFWS 1980).

The primary purpose of this study was to accumulate and assess information concerning the population dynamics and life history "strategy" of this extremely endemic cedar glade species. Delineation of the life history of *E. tennesseensis* was followed by a consideration of its reproductive and competitive competence and the effects of various combinations of factors on seed germination. The potential for allelopathic relationships between *E. tennesseensis* and some of its more frequent associates also was investigated.

LIFE HISTORY

The following phenology of *E. tennesseensis* is based on field observations made from 1970 through 1985. Seeds (achenes) are shed during fall and winter and begin germinating in early March of the following year. By late March numerous

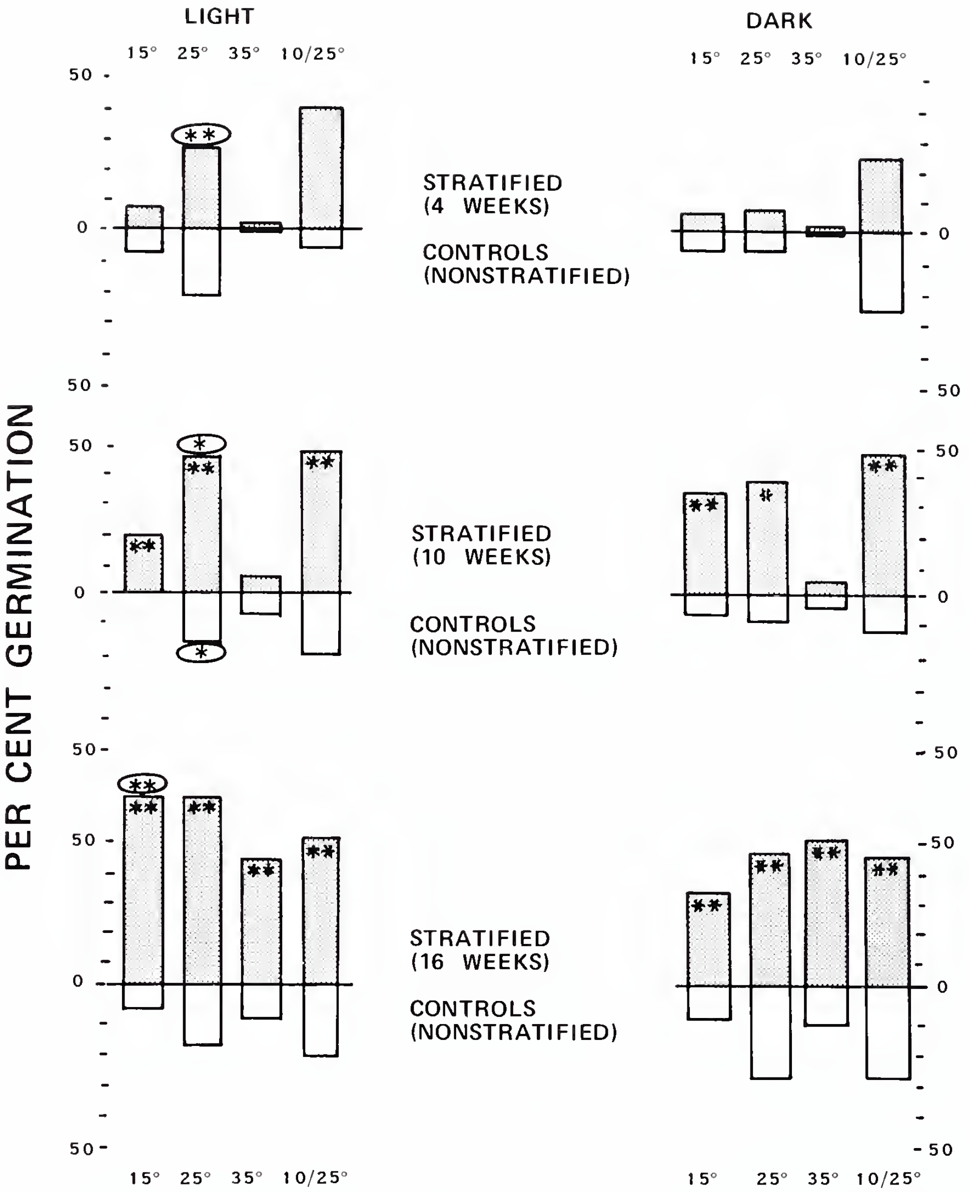

Fig. 1. Effect of stratification and dry storage on germination of *Echinacea tennesseensis* seeds in light and darkness at 4 temperatures. * Significantly different from control at 0.05 level. ** Significantly different from control at 0.01 level. ⊛ Significantly different from corresponding dark treatment at 0.05 level. (**) Significantly different from corresponding dark treatment at 0.01 level.

seedlings have appeared, often in mats of the moss *Pleurochaete squarrosa* (Brid.) Lindb. or under litter of the annual grass *Sporobolus vaginiflorus* (Torr.) Wood. During the first year, most of the seedling growth occurs within the first six or seven weeks, during which time they attain a height of 2–3 cm or less. During this same period, increase in length of roots is rapid; plants remain in a rosette stage. By May of the second growing season, bolting occurs, some of the plants

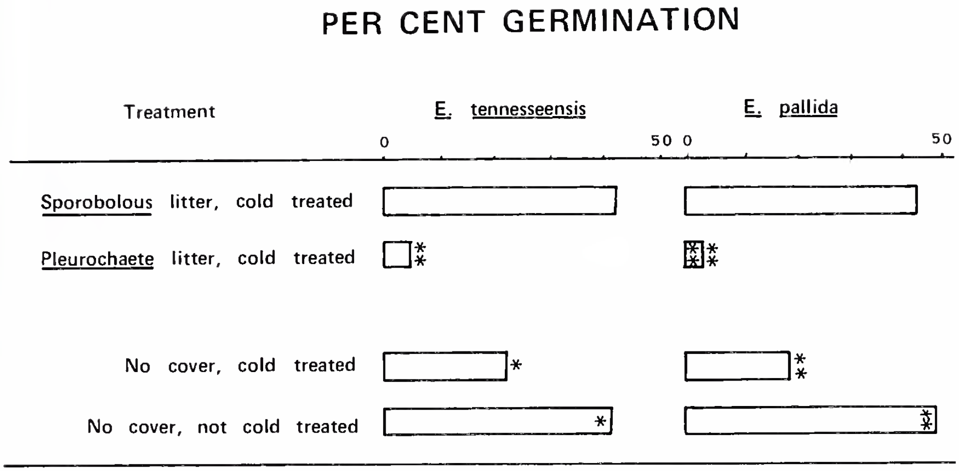

Fig. 2. Effect of sub-freezing temperatures on the subsequent germination of *Echinacea tennesseensis* seeds. ⧆ Significantly different from "no cover, cold treated" at 0.05 level. [⁑] Significantly different from "no cover, cold treated" at 0.01 level. ☐* Significantly different from "no cover, not cold treated" at 0.05 level. ☐⁑ Significantly different from "no cover, not cold treated" at 0.01 level.

flower and seeds subsequently are produced. Each natural population monitored has produced flowers and seeds each year.

EXPERIMENTAL SEED GERMINATION

Preliminary studies showed that only 10–20% of the seed germinate without pretreatment. Experiments were designed, therefore, to determine how dormancy is overcome, and to find the conditions under which the highest percentage of the seeds germinate. Also, the effects of certain unfavorable conditions on germination were studied. Seeds were tested in Petri dishes on moist filter paper in temperature- and light-controlled environmental growth chambers.

1. *Interaction of Stratification, Temperature, and Light*

Seeds were stratified under moist conditions in the dark at 5 ± 2 C for periods of 4, 10, and 16 weeks, after which they were tested at constant 10, 25, and 35 C, at a daily thermoperiod of 10/25 C in light and in darkness. Dry-stored seeds of the same age served as controls in each of the treatments.

RESULTS

An increase in the length of the stratification period resulted in an increase in the percentage of germination (Fig. 1). Temperature effects were marked, especially for seeds given little or no stratification, but less so with longer stratification periods. Light was generally stimulatory, with considerably higher percentages obtained in four instances. Among the combinations of environmental factors, the optimum was 16 weeks of stratification followed by incubation in light at 15 or 25 C; 67% of the seeds germinated under these conditions. As seeds had not been tested for viability, the percentage germination of viable seeds could be somewhat higher.

2. *Interaction of Litter and Sub-freezing Temperatures*

Seeds of *E. tennesseensis* (stratified as described previously for 16 weeks) were sown on potting soil in enamelled pans. Seeds in two pans were covered with litter (to approximate field conditions), one with the moss *Pleurochaete* and the other with *Sporobolus*; seeds in control pans remained uncovered. One of the control pans was kept at 5 C, while the other (like the two litter-covered pans) was subjected to lower temperatures. Sub-freezing (-12 ± 2 C) conditions were provided by a chest-type food freezer. Following this cold exposure, the pans were maintained in a growth chamber with an alternating thermoperiod of 10/25 C for 4 weeks in light.

RESULTS

Germination (Fig. 2) was significantly reduced ($P < 0.05$) when subjected to sub-freezing temperatures without litter. Germination of cold-treated seeds under *Sporobolus* was greater than when such cover was not present. In contrast, germination under *Pleurochaete* was minimal (4.9%).

COMPETITION

An experiment was designed to test the ability of *E. tennesseensis* to compete with its common associates, *Sporobolus vaginiflorus* and *Petalostemon gattinergi* Heller.

At each of three open cedar glade sites, 100 seeds of *E. tennesseensis* were sown into each of 24 2 × 5 dm quadrats on November, 1970. The quadrats, in replicates of six, were in four kinds of habitats: pure *Sporobolus,* pure *Petalostemon,* mixed *Sporobolus-Petalostemon,* and bare ground. Beginning the following spring, the number of *E. tennesseensis* seedlings present in each of the 72 plots was determined at three-week intervals (except for winter) until August, 1972.

RESULTS

Almost without exception, at all three sites and on each date counts were made, the mean number of *E. tennesseensis* seedlings present in plots dominated by *Sporobolus* and *Sporobolus-Petalostemon* was considerably greater than those in plots in which *Sporobolus* was not present (Fig. 3). At the end of the study, differences in numbers of *E. tennesseensis* seedlings in plots containing *Sporobolus* (*Sporobolus-Petalostemon,* 12%; *Sporobolus,* 11%) were highly significantly different ($P < 0.01$) from each of the other two plots (*Petalostemon* 4%; bare, 3%).

ALLELOPATHY

It is now well recognized that certain plant species may gain an advantage over others by release into the environment of various secondary products; the term allelopathy includes such relationships. Quarterman (1973) reported the widespread occurrence of leachable germination inhibitors which she considered to be partially responsible for the zonation typical of cedar glades.

Allelopathic (*in vitro*) studies involving *E. tennesseensis* and some of its cedar glade associates were conducted (Hemmerly 1976). The following conclusions

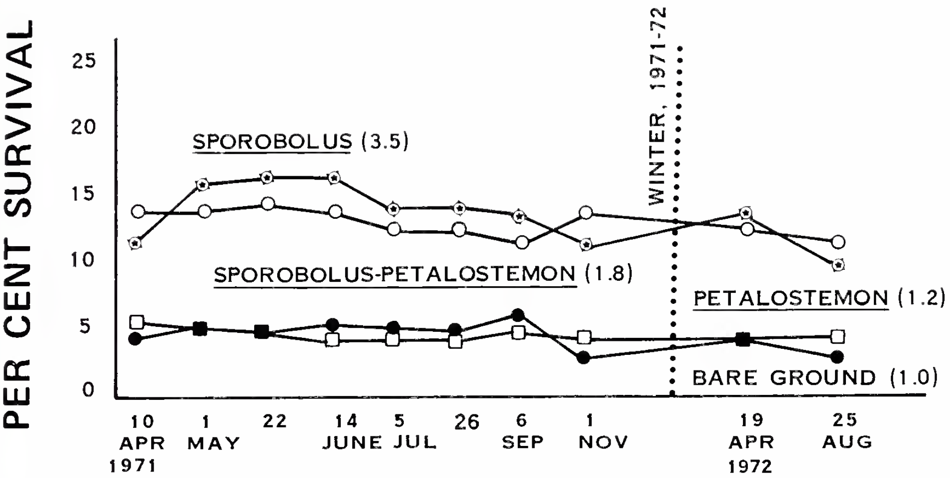

Fig. 3. Time of appearance and survival of *Echinacea tennesseensis* seedlings after sowing of seeds the preceding fall (1970). Each value represents the mean of 24 plots, 100 seeds each. Figures in parentheses indicate mean soil depth in inches.

were reached: (1) Litter of *Petalostemon gattingeri* and extracts of *Juniperus virginiana* L. each significantly inhibited the germination of seeds of *E. tennesseensis.* (2) Extracts of *E. tennesseensis* significantly inhibited the germination of seeds of *P. gattingeri, Ruellia humilis* Nutt., *Aristida longespica* Poir. and *Eragrostis spectabilis* (Pursh) Sturd. (3) Extracts of *E. tennesseensis* significantly stimulated the germination of its own seeds.

SUMMARY

During its ecological life history, the Tennessee coneflower may interact with its close associates as indicated in Fig. 4. A mature population may maintain itself by allelopathic effects on *Petalostemon, Aristida, Ruellia* and *Eragrostis.* Evidence of its general reproductive competence is its annual flowering and subsequent production of viable seeds. After dispersal of these seeds, litter of *Sporobolus* and the moss *Pleurochaete* may mulch the seeds, whereas a potentially inhibitory effect is exhibited by the same moss as well as *Juniperus* and *Petalostemon.* Whether these potentialities for allelochemic interaction are effective in the field requires further study.

Germination of seeds of *E. tennesseensis* is insured by the cold wet winters during which dormancy is broken and the seeds subsequently germinate in spring. The survival of a low but adequate number of resulting seedlings may be aided by litter of *Sporobolus* or surface rock which serve as a mulch (Zohary 1962). For any seedlings that are established into a shrub or tree zone, or where thick *Sporobolus* grass produces a dense shade, development may be retarded. As the mature plants are relatively long lived, survival to maturity of only a few individuals is sufficient for the continuation of the population.

The extreme endemism of particular species is commonly difficult to explain. Evidence presented here indicates that *E. tennesseensis* may be restricted in distribution and habitat because of its low competitive ability and its lack of any special or effective means of seed dispersal. The former restricts it to open glades;

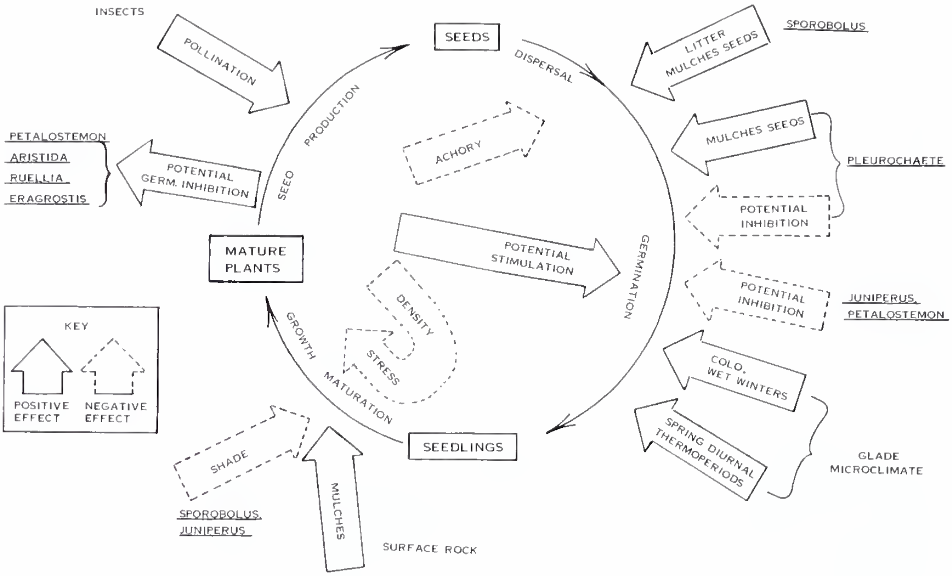

Fig. 4. Biotic and abiotic factors affecting the ecological life history of *Echinacea tennesseensis.*

the latter prevents its invasion of other nearby glades. Cedar glades are separated by densely shaded shrub and forest areas. *Echinacea* apparently evolved as a prairie genus, thus barriers to seed dispersal as described above typically are not encountered by the widespread species of this genus which presently occupy the less confined, open areas of central North America.

Although narrowly endemic to a few small open cedar glades, *E. tennesseensis* has a life history that obviously is well adapted in this microenvironment. In order to save endangered species such as *E. tennesseensis* from extinction, *in situ* perpetuation of populations is preferred (Smithsonian Institution 1975). This can be accomplished mainly by preventing exploitation of the habitat. Should the populations face more immediate destruction, deliberate seeding into nearby glade areas might be necessary.

Implementation of the Tennessee Coneflower Recovery Plan (Somers *et al.* 1983) should make certain the continued survival of this cedar glade species.

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THE DISTRIBUTION OF PHOTOSYNTHETIC PATHWAYS AMONG CEDAR GLADE PLANTS

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ABSTRACT

All known photosynthetic pathways are represented in the southeastern cedar glade flora, including C_3, C_4, and both obligate and facultative CAM species. Of 343 species considered, 88.9% were C_3 species, 7.8% were C_4 species, 1.2% were CAM species, and 2.0% were classified as unknowns. This cedar glade pattern is similar to that found in other xeric environment plant communities, where in all cases the C_3 pathway is numerically dominant.

INTRODUCTION

Three distinct pathways of CO_2 fixation have evolved and are designated C_3, C_4, and CAM photosynthesis (Osmond *et al.* 1982). In addition to the fundamental anatomical and biochemical differences, these pathways also exhibit differences in their ecophysiological adaptations and environmental optima (Black 1971; Kluge and Ting 1978; Pearcy and Ehleringer 1984). Ecophysiological differences among species having different photosynthetic pathways have been shown to be useful in understanding species biogeography and patterns of species importance at the community level in a variety of different ecosystems.

Distributions of photosynthetic pathways and their environmental correlations have been examined at several ecological scales. Teeri and colleagues have analyzed the biogeography of a number of C_4 and CAM groups in North America and have correlated the importance of the groups with environmental variables using stepwise multiple linear regression. They have examined C_4 grasses (Teeri and Stowe 1976), C_4 dicots (Stowe and Teeri 1978), the succulent CAM-dominated families Cactaceae and Crassulaceae (Teeri *et al.* 1978), and C_4 members of the Cyperaceae (Teeri *et al.* 1980). While each of these groups differs to some degree in response to environmental variables, each appears to have its greatest adaptive advantage under hot, arid, high light conditions.

Studies conducted at the community level support these generalizations. Mooney *et al.* (1974), Syvertsen *et al.* (1976), and Eickmeier (1978) examined photosynthetic pathway distributions along desert aridity gradients and found that CAM, and to a lesser degree C_4, "importance" increased with increasing site aridity. The measure of ecological importance used was % cover, % species and % biomass, and community importance value based on relative frequency and density, respectively in the order cited above. Other studies in grassland ecosystems have clearly shown that C_3 species are replaced by C_4 species along environmental gradients towards the drier and/or lower elevation end of the gradients (Boutton *et al.* 1980; Hattersley 1983; Tieszen *et al.* 1979).

Cedar glade ecosystems common to central Tennessee have complex spatial and temporal gradients of environmental variation. This is particularly true in terms of soil water potential which strongly influences photosynthetic pathway occurrence in other systems as described above. Glade environments become drier as soil depth decreases and during the summer months (Quarterman 1950a, 1950b; Baskin and Quarterman 1970). The purpose of this paper is to describe the distribution of photosynthetic pathways of the vascular herbaceous flora of southeastern cedar glades and to briefly compare this distribution pattern with those of other xeric environment plant communities.

MATERIALS AND METHODS

The photosynthetic pathway was determined for each of the 278 vascular, herbaceous cedar glade species listed in Baskin *et al.* (1968) and for the 65 additional species given by Baskin and Baskin (1975, 1985). A species was assumed to be a C_4 species if it has been reported to have either Kranz anatomy (Welkie and Caldwell 1970) or a stable carbon isotope ratio, expressed as delta ^{13}C value, of between -10 to $-20‰$ (Smith and Epstein 1971). Any species belonging to a genus (or subgenus for *Panicum*) known to contain only C_4 species was assumed to be C_4 if a pathway determination was not known for it. A nonsucculent species which either lacked Kranz anatomy or which had a reported carbon isotope ratio delta ^{13}C value of between -22 to $-33‰$ (Bender 1971) was assumed to be C_3. Any species belonging to a genus or family known to contain only C_3 species was assumed to be C_3 if a pathway determination was lacking for it. In addition to the two sources given above, Baskin and Baskin (1981, 1985), Bender (1971), Bender and Smith (1973), Brown and Smith (1972), Downton (1975), and Smith and Brown (1973) contained information that permitted identification of photosynthetic pathway for species, genera, and families of plants that occur in the cedar glades. Particular care was taken in classifying species from genera or families where both C_3 and C_4 species have been found. Unless information allowing an unambiguous pathway determination was found for these species, they were listed as unknown.

CAM species were established based on several criteria which included net nocturnal CO_2 uptake, substantial cell titratable acidity fluctuation from morning to evening, C_4-like carbon isotope ratio, and low ribulose bisphosphate carboxylase to phosphoenol pyuruvate carboxylase ratio (for explanation of criteria see Kluge and Ting 1978). CAM plants were identified using these criteria taken from Bender *et al.* (1973), Koch and Kennedy (1980), Martin and Zee (1983), Martin *et al.* (1982), Smith and Eickmeier (1983), and Szarek and Ting (1977). CAM plants were further identified as either obligate or facultative CAM species. In facultative CAM taxa, CAM-like characteristics can be induced most often by water stress in plants that normally behave as C_3 plants when well supplied with water (Kluge and Ting 1978).

RESULTS

A total of 343 vascular herbaceous species were considered in the survey (Table 1). Pathway determinations were made at the family level for 233 species (all C_3), at the genus or subgenus level for 43 species (36 C_3, 7 C_4), and at the species level for 60 species (36 C_3, 20 C_4, and 4 CAM). Seven species were designated as unknown. Most cedar glade species utilize C_3 photosynthesis (88.9%). The C_4 pathway occurs in 7.8% of the species, most of them in the family Gramineae. The members of this family are about equally divided between the C_3 and C_4 pathways (49% and 51% respectively). Despite this numerical similarity, most of

Table 1. The distribution of photosynthetic pathways among 336 herbaceous vascular plants of southeastern cedar glades. Floristic data are from Baskin et al. (1968) and Baskin and Baskin (1975, 1985). Pathway determinations are based on criteria and references given in the text.

Pathway		# Species	% of flora
C_3	Gramineae	21	
	Non-Gramineae	284	
	Total	305	88.9
C_4	Gramineae	22	
	Non-Gramineae	5	
	Total	27	7.8
CAM	Obligate	2	
	Facultative	2	
	Total	4	1.2
Unknown		7	2.0

the ecologically dominant grass genera (*i.e. Andropogon, Aristida,* and *Sporobolus*) were all C_4. Four species representing 1.2% of the glade flora have characteristics that are indicative of either obligate or facultative CAM.

Seven species could not be placed in the preceding categories. These include *Cyperus ovularis* (Michx.) Torr. and *Euphorbia obtusata* Pursh for which no specific information was found and which occur in genera that have been shown to contain more than one photosynthetic pathway. The species *Scleria pauciflora* Muhl., *Scirpus atrovirens* Willd., and *Scirpus lineatus* Michx., all in the Cyperaceae, occur in two genera where only a single species has been identified and classified as a C_4 species. With only one determination, no generalizations can be made at the generic level for these species and they are listed as unknowns. In addition, *Mollugo verticillata* L. has been reported to have characteristics intermediate between C_3 and C_4 pathways (Kennedy and Laetsch 1974; Sayre and Kennedy 1977) and *Yucca filamentosa* L. has been reported as both a CAM (Szarek and Ting 1977) and a C_3 (Bender 1971; Martin *et al.* 1982) species so that its status cannot be determined accurately from the literature. All of these unknown species, except for *E. obtusata,* have been reported as either rare or infrequent by Baskin *et al.* (1968) or Baskin and Baskin (1975) and so are probably of minor ecological importance.

The four CAM species, while representing a small percentage of the glade flora, are sometimes ecologically dominant in shallow soil habitats on open limestone glades (Quarterman 1950b). Two of the four species are obligate in their CAM physiology. Both *Agave virginica* L. and *Opuntia compressa* (Salisb.) Macbr. have substantial nocturnal net CO_2 uptake, large titratable acidity fluctuations, and C_4-like carbon isotope ratios (Bender *et al.* 1973; Koch and Kennedy 1980; Martin *et al.* 1982; Smith and Eickmeier 1983) and C_3-like characteristics never have been reported to develop. In addition, Smith and Eickmeier (1983) reported that the RuBP carboxylase to PEP carboxylase ratio of *O. compressa* was low throughout the growing season, thus supporting the conclusion that this is an obligate CAM species.

The remaining two CAM species, the annual *Sedum pulchellum* Michx., and the perennial *Talinum calcaricum* Ware, appear to have a variable physiology indicative of facultative CAM. While the glade species *T. calcaricum* itself has not yet been investigated, its close relatives *T. teretifolium* of the granite outcrops (Martin *et al.* 1982) and *T. calycinum* from sandstone outcrops (Martin and Zee 1983) have characteristics that indicate a flexible CAM capability when under water stress. *Talinum calcaricum* will most likely follow this pattern. *Sedum pulchellum* has clearly been shown to operate as a normal C_3 species until exposed to substantial water stress in situ on the cedar glades (Smith and Eickmeier 1983).

DISCUSSION

A knowledge of the pattern of photosynthetic pathway distributions over time and space is important to a full understanding of the ecology of the cedar glades. This information contributes to our appreciation of both the autecology of individual species and community-level interactions. The results of this initial cedar glade flora analysis are similar in many respects to those obtained from the analysis of desert communities. In these cases, including Sonoran, Chihuahuan, and Chilean deserts, C_3 species are numerically dominant. In one respect this comparison may be trivial as C_3 species dominance appears to be almost universal, but it does support the nontrivial contention of Baskin and Baskin (1981) that C_4 or CAM photosynthesis is not a prerequisite for adaptation to the hot, dry, high-light environment of the glades. In fact, the species that are endemic to the cedar glades that have been investigated are all C_3 species (Baskin and Baskin 1985). When considering unshaded rock outcrop endemics of the unglaciated eastern United States, including those of serpentine and shale barrens and granite/sandstone/chert outcrops, Baskin and Baskin (1985) hypothesized that about 95% of the 90 taxa use C_3 photosynthesis. This estimate only slightly exceeds the value found for the entire cedar glade flora.

Mooney *et al.* (1974) found that even in the driest parts of both Baja California and the Chilean coastal deserts greater than 70% of the species were C_3 while 25% or less were CAM. The C_4 pathway was virtually unrepresented in both of these areas. Similar results were reported by Syvertsen *et al.* (1976) for the bajada community of the Chihuahuan desert (66% C_3, 24% C_4, and 10% CAM species) and by Eickmeier (1978) for an elevational gradient in Big Bend National Park, TX (72% C_3, 3% C_4, and 25% CAM species). Thus, in a qualitative sense the photosynthetic diversity in plants of the cedar glades matches that seen in more arid ecosystems, although on a quantitative basis the glades have more C_3 and fewer CAM species than these other systems.

Pathway representation based only on species percentages, however, may underestimate actual ecological importance. For example, Syvertsen *et al.* (1976) found that while representing only about 10% of the species, plants with the CAM pathway made up 48% of the total community biomass. In a similar manner, the biomass contribution of CAM species to shallow soil, glade environments appears to be greater than its species number contribution alone would suggest. A more detailed analysis of photosynthetie pathway importance on a more ecologically significant basis would be very useful.

In conclusion, a consideration of the photosynthetic pathway properties of a plant community can be useful in interpreting spatial and temporal aspects of community structure. It is also clear, however, that at the level of individual species, many features in addition to photosynthetic pathway contribute to its success in relation to both its biotic and abiotic environment.

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THE HERPETOFAUNA OF THE CEDARS OF LEBANON STATE PARK, FOREST, AND NATURAL AREA

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ABSTRACT

Thirteen families of amphibians and reptiles are known to inhabit Cedars of Lebanon State Park, Forest, and Natural Area (Wilson Co., Tennessee). Sixteen species of amphibians, and 19 reptiles have been recorded. Certain species common to Middle Tennessee are rare or absent in the glades while others appear to be more abundant. Among the latter are *Cnemidophorous sexlineatus*, *Eumeces inexpectatus*, *Tantilla coronata*, and *Lampropeltis getulus*.

INTRODUCTION

Although several regional surveys of amphibian and reptilian populations have been conducted in Tennessee, only one (Jordan *et al.* 1968) involved a comprehensive tabulation of those frequenting the cedar glades of the mid-state area. This study, and subsequent observation, has revealed the presence of 16 species of amphibians (6 salamanders, 8 frogs, and 2 toads) and 19 species of reptiles (12 snakes, 5 lizards, and 2 turtles) in the Cedars of Lebanon State Park, Forest, and Natural Area (Wilson County, Tennessee).

STUDY AREA

Cedars of Lebanon State Park, Forest, and Natural Area is located in Middle Tennessee's Nashville Basin, some 49 km east of Nashville astride U.S. Highway 231, 16 km south of Lebanon. Cedars of Lebanon State Park occupies approximately 120 ha within the 3200 ha state forest. Braun (1964) described the geology and flora of the region. More detailed floristic and vegetational descriptions appear elsewhere in this volume.

The glades are composed of dense-to-sparse stands of red cedar (*Juniperus virginiana* L.), intermixed with deciduous trees and shrubs, growing in shallow soil underlain by Ordovician limestone. The study area contained a wet weather creek, shallow temporary pools and two permanent bodies of water. One of these, a shallow rectangular pond, hewn from the limestone, measured 5 × 10 m. The second, inside the state park, was 13 m long and 1–2 m wide.

METHODS

This survey was initiated in 1967 and has continued intermittently since. Personal field searches, periodic student field trips, and communication with persons familiar with the herpetofauna of the area have occurred in the ensuing years. Representative specimens are housed in the vertebrate collection of the Department of Biology, Tennessee Technological University, Cookeville.

RESULTS

Sixteen amphibian species and 19 species of reptiles are known to occur in the Middle Tennessee cedar glade sampled. An annotated listing follows:

CLASS AMPHIBIA

ORDER CAUDATA

FAMILY AMBYSTOMATIDAE

1. Marbled Salamander, *Ambystoma opacum* (Gravenhorst)

Typically an autumn-breeding species, this salamander is known from the glades via one adult specimen, taken in the spring. Although no breeding sites are known in the area sampled, the species has been recorded from the same county (Sinclair, 1950) and is locally abundant in other mid-state areas.

2. Spotted Salamander, *Ambystoma maculatum* (Shaw)

This species is almost as rare in the glades as its previously listed relative. Two adults have been recorded and larvae were reported by Glenn Gentry (pers. comm.) in 1967. It too appears to be more common in other parts of Middle Tennessee. Both species of *Ambystoma* mentioned here are usually associated with a deciduous forest habitat.

FAMILY SALAMANDRIDAE

3. Red Spotted Newt, *Notophthalmus viridescens* (Rafinesque)

Adult newts may be found in the rectangular pond throughout the year. They are most easily observed in the spring when courtship activity brings considerable numbers of them to the surface. They are less conspicuous at other times of the year when they conceal themselves beneath algae and bottom debris. This is the only aquatic salamander of the area and is the most numerous species of caudate amphibians. Occasionally, immature terrestrial forms ("red efts") are encountered in other areas of the glades.

FAMILY PLETHODONTIDAE

4. Zigzag Salamander, *Plethodon dorsalis dorsalis* Cope

Commonly found under rocks, logs, and other surface debris, the zigzag salamander is the most abundant and widely distributed terrestrial salamander of the glades during early spring. As warmer and drier conditions become prevalent, these diminutive salamanders retreat deeper into the substrate and become increasingly difficult to locate. Conant (1975) indicates a preference of this species for rock slides, a condition similar to the rocky surface found in abundance throughout the glades. Also, the young do not require pools for development. These two habitat conditions appear to favor the species in the cedar glades.

5. Green Salamander, *Aneides aeneus* (Cope and Packard)

Green salamanders, a woodland species, are commonly associated with moist, fissured sandstone rock faces within the Appalachian Mountains. The species was reported by McKinney and Snyder (1973) from a sinkhole in Cedars of Lebanon State Park. This is a western range extension for the animals of some 90 km and likely represents a relict population. All other members of the genus are western in distribution.

6. Cave Salamander, *Eurycea lucifuga* (Rafinesque)

Although limestone sinks and caves, sometimes frequented by this species, are present within the glades, these brightly colored salamanders have been taken most often on roads during rainy evenings. An occasional specimen may be found under logs or stones at other times. Sinclair (1950) found the species in other parts of Wilson County, and their occurrence in caves of the Central Basin is well documented (Paul Hamel, pers. comm.).

ORDER ANURA
FAMILY BUFONIDAE

7. American Toad, *Bufo americanus americanus* Holbrook
8. Fowler's Toad, *Bufo woodhousei fowleri* Hinckley

Both of these species of toads are present in the cedar glades. Fowler's toad is by far more abundant. Other Middle Tennessee studies (Harris 1967; DeLotelle 1976; Woolcott 1981) indicate *B. americanus* to be more common in deciduous forests. The drier and more open nature of the glades appears to favor *B. woodhousei fowleri.* Consequently, they are the most frequently encountered toads at all seasons.

FAMILY HYLIDAE

9. Cricket Frog, *Acris crepitans* Baird

Population estimates of these small, active frogs have not been attempted in the glades. They are, however, abundant from early spring through fall in any area offering sufficient moisture, which is usually near temporary pools and intermittent streams. Occasionally they may also be found some distance from water.

10. Upland Chorus Frog, *Pseudacris triserata feriarum* (Baird)

Another small anuran represented in the cedar glades is the chorus frog. They may be observed, or more often heard calling, from late winter into early summer. Their usual habitat is any low area which retains shallow water temporarily.

11. Gray Tree Frog, *Hyla versicolor versicolor* LeConte

This is the only "true" tree frog native to the glades. They are seldom seen but, on occasion, may be observed around temporary bodies of still water from mid-April on. They appear to be widely distributed in the area and can be heard calling, from dusk into the night, throughout the summer.

FAMILY MICROHYLIDAE

12. Eastern Narrow-Mouthed Toad, *Gastrophryne carolinensis* (Holbrook)

The true abundance of these small, secretive anurans is difficult to ascertain. Their appearance is sporadic and usually linked to periods of heavy rainfall. They are seldom seen in the open but are most likely to be found beneath stones, boards, and similar debris. Their odd, somewhat nasal calls may be heard into late summer, especially just before or after showers.

FAMILY RANIDAE

13. Bullfrog, *Rana catesbeiana* Shaw

This species is usually associated, throughout its range, with relatively large permanent bodies of water. Such habitats are scarce in the glades. Although bullfrogs are present in the area, they are neither as abundant, nor do they appear to grow as large, as elsewhere in Middle Tennessee. They are occasionally found around the two bodies of permanent water in the study area, as well as in pools of intermittent streams and roadside puddles. They may also be encountered beneath stones, etc., near these situations.

14. Green Frog, *Rana clamitans melanota* (Rafinesque)

Like the bullfrogs of the glades, which these most closely resemble, the green frogs of the area are relatively smaller and less numerous than those at other Middle Tennessee locales. Green frogs are limited to sites with considerable moisture within the study area.

15. Pickerel Frog, *Rana palustris* LeConte

Throughout much of its Middle Tennessee range, the pickerel frog is associated with clear, cool streams, and rocky ravines, a condition absent in the glades. It is, therefore, uncommon in the cedar glade sampled. One specimen is known from the study area (Jordan *et al.* 1968).

16. Southern Leopard Frog, *Rana utricularia* Harlan

Leopard frogs typically inhabitat areas with abundant sources of fresh water, except during the summer when they may wander far afield. This species is not abundant in the glades but occurs in larger numbers than does the pickerel frog, which it superficially resembles. It may be encountered any time during spring or summer, usually near water. This water may be no deeper than that collected in ruts of little-used access roads.

CLASS REPTILIA

ORDER TESTUDINATA

FAMILY EMYDIDAE

1. Eastern Box Turtle, *Terrapene carolina carolina* (Linnaeus)

The box turtle is the ubiquitous land tortoise of most of the mid-state area. It is, however, most often associated with a deciduous forest habitat. Although this turtle is present in the glades, it appears to be much less common here than in surrounding areas.

2. Red-eared Turtle, *Chrysemys scripta elegans* (Wied)

The red-eared turtle is strictly an aquatic species with an apparent preference for relatively large bodies of water. Only one immature specimen, taken from the pool near the state park headquarters, is known from the cedar glades.

ORDER SQUAMATA

SUBORDER LACERTILIA

FAMILY IGUANIDAE

3. Northern Fence Lizard, *Sceloporous undulatus hyacinthinus* (Green)

This lizard is common in a variety of habitats throughout Middle Tennessee. The open, dry, rock-strewn nature of the glades environment, however, appears to favor this species particularly, providing ample basking sites and cover for itself and prey species. It is the most active and easily observed lizard of the glades. Further, it is the most abundant reptile of the area, as indicated by the 103 individuals recorded in a three-month period in 1967 (Jordan *et al.* 1968).

FAMILY SCINCIDAE

4. Five-lined Skink, *Eumeces fasciatus* (Linnaeus)

Five-lined skinks are presumed to occur statewide and are usually associated with mesic forest habitats where they occupy decaying logs, other woody debris, or rocky shelter. In the glades, this species appears to show a preference for the most densely wooded areas, frequenting stone walls, rocky debris or the loose bark of fallen trees. They also exhibit a tendency to ascend trees when disturbed. Nineteen individuals were identified in one study (Jordan *et al.* 1968), and 29 were encountered by Ellis (1968).

5. Southeastern Five-lined Skink, *Eumeces inexpectatus* Taylor

Although Conant's (1975) range map indicates the presence of this lizard over much of eastern and middle Tennessee, its occurrence is somewhat limited by habitat within this range. The more open, xeric parts of the cedar glades are home to this species. Since such conditions prevail over much of the cedar forest, this is the most abundant of three skinks in the glades. Sixty-one specimens were recorded in two studies in the glades (Jordan *et al.* 1968; Ellis 1968). *Eumeces inexpectatus* is invariably encountered in contact with the ground, usually under rocks and sometimes in shallow burrows beneath the stones. Unlike *E. fasciatus,* this species rarely attempts to climb trees in its escape efforts and seldom is encountered basking.

6. Broad-headed Skink, *Eumeces laticeps* (Schneider)

Broad-headed skinks are the largest, most arboreal, and rarest of the three skinks in the glades. Although it probably occurs statewide (Barbour 1971; Conant 1975; Mount 1975), it is nowhere abundant. The scarcity of cavity-bearing deciduous trees likely accounts for their infrequent occurrence in the glades.

FAMILY TEIIDAE

7. Six-lined Racerunner, *Cnemidophorous sexlineatus* (Linnaeus)

Racerunners frequent the most open, dry, and rocky areas of the cedar glades. Dryness is cited by Smith (1946) as the most crucial factor in habitat selection by this species. They freely expose themselves while basking in the sun and, with speed and agility, secure themselves in shallow burrows beneath stones when disturbed. Smith (1946) and Fitch (1958) refer to the construction and use of such burrows throughout their range.

When air temperatures exceed 31 C in the glades, these lizards are the most evident reptile of the area. Mount (1975) indicates that the optimum body temperature for this species is about 40 C, apparently well above that of most other native reptiles.

Although racerunners appear to occur statewide (Barbour 1971; Conant 1975; Mount 1975; Smith 1961), Gentry (1956) did not record their presence in Wilson County. I have found the animals nowhere as abundant and readily observable as those of the cedar glade population. This is the only reptile of the glades "deemed in need of management" by the Tennessee Department of Conservation and the Tennessee Wildlife Resources Agency (Eagar and Hatcher 1980).

SUBORDER SERPENTES

FAMILY COLUBRIDAE

8. Eastern Garter Snake, *Thamnophis sirtalis sirtalis* (Linnaeus)

This species, like its relatives the water snakes, frequents moist situations over much of its range (Barbour 1971; Conant 1975; Martof *et al.* 1980). Its preferred food items (earthworms, frogs, and salamanders) are also dependent upon ample moisture, a factor in limited supply in the glades during much of the year. Garter snakes are present in the region but are not nearly as common as in other mid-state habitats.

9. Eastern Hognose Snake, *Heterodon platyrhinos platyrhinos* Latreille

The hognose snake, known locally as "spread head" or "spreading adder," is well known for its defensive behavior pattern of flattening the head and neck, hissing and "playing dead." Statewide in distribution, it may be found in many habitats but appears to prefer areas with loose or sandy soil, into which it may burrow. The shallow soil of the glades, combined with a scarcity of toads, a favorite food item, appears to be a factor which limits their occurrence in the glades. The species is recorded from the area but only in small numbers. Barbour (1971) notes their apparent scarcity in the Blue Grass region of Kentucky, an area well known also for the presence of limestone.

10. Northern Ringneck Snake, *Diadophis punctatus edwardsi* (Merrem)

A small (25–40 cm), dark gray, secretive snake, the ringneck is seldom seen abroad but may be retrieved from moist ground beneath stones or other surface litter. In the glades, these snakes are invariably found only a few centimeters from the more heavily wooded areas.

11. Midwest Worm Snake, *Carphophis amoenus helenae* (Kennicott)

These small (17–30 cm), shiny brown serpents, which superficially resemble large earthworms, may well be the most abundant snakes of the cedar glades. They are common under stones, especially during the wetter spring months. As summer progresses, they retreat into the substrate and become increasingly difficult to find. Although two subspecies of worm snakes (*C. a. amoenus* and *C. a. helenae*) occur in the state, the cedar glade population is currently assigned to *C. a. helenae* (Jordan *et al.* 1968).

12. Northern Black Racer, *Coluber constrictor constrictor* Linnaeus

Two subspecies (*C. c. constrictor* and *C. c. priapus*) of racers are known from Tennessee (Conant 1975; Wright and Wright 1957), but the cedar glades population falls well within the range of the northern subspecies. This is a large, slender snake which is active by day and may be found in open areas, but more often near forest edges, fence rows, and along roadsides. The widespread belief that these snakes attack and/or pursue humans without provocation is apparently unfounded. Their abundance in the glades varies. Some years several may be found within a few hours whereas in other years they appear scarce. Unlike many snakes, they are somewhat non-specific in their diet and may feed upon amphibians, reptiles, birds, their eggs, small mammals, and even insects. The lizard population of the glades undoubtedly contributes markedly to their fare.

13. Black Rat Snake, *Elaphe obsoleta* (Say)

The rat snakes of Middle Tennessee often exhibit traits of two subspecies: black rat snake (*E. o. obsoleta*) and gray rat snake (*E. o. spiloides*). Those of the glades are no exception and may vary in color from solid black to patterned individuals with dark brown dorsal blotches on a lighter gray or brown ground color. This "chicken snake" of the locals is not abundant but may be encountered occasionally, usually in the more heavily wooded areas. The rat snakes attain the greatest length of any snake in the cedar glades, with adults averaging one to two meters in length.

14. Black Kingsnake, *Lampropeltis getulus niger* (Yarrow)

This is the third relatively large snake of the cedar glades which is black in color. It differs from the others chiefly in having scattered yellow or cream colored flecks on the back and sides. These light markings are larger on the sides and extend onto the belly. The head is also smaller than that of the racer and black rat snake.

Black kingsnakes are found over much of the mid-state area but appear to be more frequently encountered in the glades than elsewhere. They are known to feed on lizards, which abound there, in addition to snakes, birds, reptile and bird eggs, and small mammals. These snakes are belligerent when first encountered but tame down readily after capture.

15. Eastern Milk Snake, *Lampropeltis triangulum triangulum* (Lacepede)
16. Red Milk Snake, *Lampropeltis triangulum syspila* (Cope)

Both of the above races of this highly variable species may be found in the cedar glades, although Conant (1975) and Sinclair (1965b) reported only the presence of eastern milk snakes in Wilson County. Each is a handsome snake with dorsal blotches of chestnut brown (*L. t. triangulum*) or red saddles (*L. t. syspila*) encircled by black. They may best be located under stones in open areas. All of the red milk snakes taken were found west of U.S. Highway 231 in Cedars of Lebanon State Forest.

Conant (1938) found a correlation between the presence of dense small snake populations and the occurrence of milk snakes in Ohio. Worm snakes (*Carphophis*), as well as several lizard species, are abundant in the glades at certain times. All of these are known to serve as prey items for both milk snakes (Behler and King 1979; Martof *et al.* 1980; Mount 1975). This factor, combined with the abundant rock cover, may well influence their presence there.

17. Northern Scarlet Snake, *Cemophora coccinea copei* Jan

Scarlet snakes, strikingly colored with their red, cream and black pattern, are known from the cedar glades via one specimen taken from beneath a stone in a clearing. Although this individual was collected about mid-day in the spring of 1968, the species is generally considered to be nocturnal (Behler and King 1979; Conant 1975; Martof *et al.* 1980). This small fossorial constrictor is nowhere common, perhaps because it is truly scarce or perhaps because of its secretive habits. Its preferred food appears to be reptile eggs (Behler and King 1979; Martof *et al.* 1980; Mount 1975) which are readily available in the glades.

18. Southeastern Crowned Snake, *Tantilla coronata coronata* Baird and Girard

Crowned snakes are small, mildly venomous, burrowing snakes which appear to be relatively common in the wooded areas of the glades. There they may be found under rocks, usually in contact with moist soil. Sinclair (1965a) found them to be associated with the presence of racerunners (*C. sexlineatus*) in the cedar glades of Middle Tennessee and parts of Alabama. The habitat requirements given for this species in Kentucky (Barbour 1971) and in Alabama (Mount 1975) rather closely parallel available microhabitats of the glades. Ground dwelling insects, arachnids, and centipedes, known food items of *Tantilla,* are common in the area as well. Any small, brownish "ground" snake of the glades should be examined for a black cap and black collar, markings which give the animal its common name.

FAMILY VIPERIDAE

19. Timber Rattlesnake, *Crotalus horridus* Linnaeus

Of the 12 species of snakes native to the cedar glades, only the timber rattlesnake can be considered dangerous. Rattlers occasionally frequent the area roads, especially at night during hot summer weather. The fissured rock outcrops of the cedar forest provide adequate cover for the species. This habitat is consistent with descriptions given for other regions (Barbour 1971; Behler and King 1979; Smith 1956; Smith 1961).

DISCUSSION

When compared to other Middle Tennessee sites, the glade populations of the following species appear to be larger: fence lizards (*Sceloporous undulatus*), racerunners (*Cnemidophorus sexlineatus*), southeastern five-lined skinks (*Eumeces inexpectatus*), kingsnakes (*Lampropeltis getulus*), milk snakes (*L. triangulum*), and crowned snakes (*Tantilla coronata*). The dry, rock-strewn clearings within the cedar forest appear to favor the lizards especially, providing ample shelter (for them and prey) and basking places. The availability of lizards may, in turn, account for the abundance of kingsnakes and milk snakes which are known predators of various lizards.

The glades' environment apparently offers relatively poor habitat for species more commonly encountered in other areas of Middle Tennessee. Relatively few salamander species are known from the glades, and some of these appear to have small populations. Caudate genera, normally associated with moist, hardwood forests outside the glades are absent (*Desmognathus*) or scarce (*Ambystoma, Eurycea,* and *Plethodon*). Anuran taxa are better represented, but the populations are likewise relatively small.

Those reptiles usually associated with mid-state deciduous forests are also poorly represented in the glades. Snakes, such as *Elapahe obsoleta, Thamnophis sirtalis,* and *Crotalus horridus* are rare; while the genera *Nerodia, Agkistrodon, Storeria, Virginia,* and *Opheodrys* are apparently absent.

The limited number of permanent surface water sources undoubtedly influences the populations of water snakes, garter snakes, and aquatic turtles. The lack of suitable habitat for prey species of such snakes as *Elaphe* and *Crotalus* may account for their limited distribution.

SUMMARY

The species of reptiles and amphibians known to inhabit the Cedars of Lebanon State Park, Forest, and Natural Area (Wilson Co., Tennessee) appear to be related directly to the somewhat xeric, open nature of this area. Species common to other mid-state locations are rare or absent in the glades, while certain species are apparently more frequently encountered in the glades than elsewhere.

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PRESIDENT'S CORNER

A VIEW FROM HERE

The Association of Southeastern Biologists will celebrate its 50th Anniversary when we convene on the University of Georgia campus in April 1987. This marks an important milestone in the history of the society and represents an opportune time for reflection concerning the present and future status of ASB. I would like to share my personal thoughts about the society as we near this important juncture. First, let me express my sincere appreciation to our immediate Past President, Lafayette Frederick, for his outstanding leadership in managing the society in a very professional fashion over the past year.

The society has certainly experienced strong growth since the initial meeting of 58 founding members at the University of Georgia in May 1937. Much of what has transpired over the intervening years will be documented in an article scheduled for publication in the ASB Bulletin. The important point to note is that we have attained considerable stability as an organization and can take definite pride in the successful satisfaction of our objectives of promoting research and the preservation of biological resources within the southeast. Those individuals who have served as past officers or committee members should feel proud of their role in making this possible.

Events of the past year attest to the continued success of ASB as perhaps the largest regional organization of biologists in the United States. Foremost is our recent annual meeting at the University of South Carolina in Columbia which was an overwhelming success by any standards. Those of us attending particularly enjoyed the warm hospitality displayed by the USC staff throughout the meeting. Bob Bruck's stirring plenary address on the effects of air pollution on southeastern forests set the stage for two days of excellent symposia and paper presentations involving ASB members and representatives of six societies meeting with ASB. The participation of 25 exhibitors was the largest in years and promoted an excellent attendance at exhibits. The field trips and socials collectively succeeded in promoting the sense of community and friendship which is so important among ASB members. The meeting was especially successful in providing an unprecedented $5000 profit for the society. We are deeply indebted to John Herr and David Rembert for their outstanding efforts in handling what proved to be a very memorable meeting.

The society has profited from its strong foundation and now enjoys a solid reputation among southeastern biologists. Despite this, we should continue to seek the ways and means of strengthening ASB's future. As a result, the Executive Committee has reestablished its mid-year meeting and is convening on the University of North Carolina–Charlotte campus in July to consider several issues. The major items being addressed include the ASB Bulletin, meeting attendance, numbers of paper presentations, society membership, the role of affiliated societies and implementation of the Enrichment Fund.

The ASB Bulletin has served as an effective means of transmitting information about ASB activities and biologists in the southeast since its inception in 1954. Jim Hardin, our recent editor, worked diligently over the past six years to increase the input of research papers in the Bulletin. I would hope more of this type of format would be possible in the future. The Cedar Glades symposium in the present issue is an example of what can be done. We are currently examining ways of enabling the ASB Bulletin to become an even more effective research outlet. Frank Schwartz, our current editor, is committed to this philosophy and would welcome ideas or manuscripts in achieving this objective. We are also considering the financial implications of an expanded format and the role of the Enrichment Fund in making this possible.

Attendance and paper presentations at our annual meetings have been relatively stable in recent years, but remain below levels often achieved in the 1960's. Part of this difference has involved the splitting off of several disciplines which now meet separately within the region. To offset this, Becky Sharitz (President Elect) and Bill Martin (Vice President) have been contacting other southeastern societies and we anticipate a few new groups of biologists meeting with ASB in 1987. This should expand the meeting program and may lead to new ASB memberships from among those attending. In return, we are considering ways of strengthening interactions with those societies meeting annually with ASB through enhanced correspondence, regular attendance of one of their officers at ASB Executive Committee Meetings and in soliciting recommendations for individuals to serve on ASB committees. I am firmly convinced these societies can play a key role in the future growth of ASB and I would welcome any further suggestions which might prove helpful in this regard. I would also encourage each of you to discuss ASB with your colleagues, including new faculty or graduate students as well as any former ASB members that were active in the past. A little enthusiasm can go a long way in ensuring a commitment to ASB membership and meeting attendance. We should have a very special meeting planned for our 50th Anniversary at the University of Georgia. This would be the opportune time for this commitment.

The financial status of ASB, although solid, offers little flexibility in attempting new ventures. The Enrichment Fund would provide this flexibility in endowing honoraria and ASB awards for research and graduate student travel to attend the annual meetings. The provisions of the Enrichment Fund were published in the January 1986 issue of the ASB Bulletin. They will be voted on as a proposed addition to our Bylaws at the 1987 meeting. At that time, and in conjunction with our 50th Anniversary, we hope to solicit contributions aimed at significantly increasing the financial holdings of the society. I would ask that you reflect on what ASB has meant to you and your students over the years. Consider what you might be willing to provide to enhance the financial support for graduate student awards, invited speakers at meetings, ASB Bulletin publications or other ASB activities in the future. This offers a chance for each of us to do something special and lasting for our society.

The members of the Executive Committee will remain active throughout the year in addressing these and other issues. We would appreciate your ideas and suggestions concerning ways of strengthening ASB in the future. I encourage all of you to make a commitment to attend the 50th Anniversary meeting in Georgia as we return to the location where ASB was founded. This should be an ideal opportunity to renew old friendships, promote new membership and to share your research efforts with colleagues within the region.

—Donald J. Shure, President

News of Biology in the Southeast

John R. Fortman—*News Editor*
Division of Science and Mathematics
Mississippi University for Women
Columbus, Mississippi 39701

ABOUT PEOPLE AND PLACES

Alabama

Auburn University, Department of Botany, Plant Pathology and Microbiology. *Dr. U. L. Diener* and *Dr. R. Rodriguez-Kabana* were invited participants in international workshops held early in 1986. *Dr. Diener* conducted sessions in detection of mycotoxins at the US-AID/CIMMYT Aflatoxin Workshop held at Mexico City, Mexico, in April 1986. *Dr. Rodriguez* discussed control methods at the Second International Workshop on Biological Control of Nematodes held at the University of Philippines, Los Banos, in February 1986. *Dr. John D. Freeman* has been named Hesler Visiting Professor in Botany at the University of Tennessee, Knoxville, for a three-week period beginning in April 1986. *Dr. Freeman* continues on sabbatical leave to conduct plant taxonomic research at various institutions and herbaria throughout the eastern United States. *Dr. John D. Weete* was named recipient of the 1985 Directors Research Award. The Award, presented by *Dr. D. H. Teem,* Director of the Alabama Agricultural Experiment Station, was given to *Dr. Weete* for outstanding research in fungal physiology and biochemistry with special emphasis on fungal lipid biochemistry. *Dr. Ann Rushing,* formerly of the Department of Plant Pathology, University of Illinois, recently joined the department as Postdoctoral Electron Microscopist.

Auburn University, Department of Botany, Plant Pathology and Microbiology. *Dr. John D. Weete* presented invitational lectures on his research in fungal lipid biosynthesis at the University of Georgia, at Albany, California, and Honolulu, Hawaii. *Dr. Weete* was recently elected a Fellow of The American Academy of Microbiology, a component part of The American Society for Microbiology. *Dr. Paul A. Backman* presented an invitational paper entitled "Soybean Stem Canker" at the American Soybean Association meetings held in St. Louis, Missouri. *Dr. Alfred E. Brown* and *Dr. Roland R. Dute* were initiated into membership of Gamma Sigma Delta at the honor society's Spring Banquet.

Georgia

Columbus College, Department of Biology. *Glenn D. Stokes,* Assistant Professor of Biology, has been named Assistant Dean of the School of Science.

Louisiana

Louisiana State University, Department of Botany. *Dr. M. Blackwell* attended Friends of the Farlow annual lecture and botany seminar, Harvard. He was also invited to present a Fungal/Arthropod Interfaces paper at the USA symposium on Interfaces, Amherst AIBS. *Dr. K. Clay* has been elected Vice-Chairman, Ecological Section, BSA for 1987. He also presented an invited symposium address on "Microbial Toxins in Nature" to the Ottawa Society of Biochemistry and Biology. *Dr. D. Longstreth* was elected Chairman of the Southern Section of the American Society of Plant Physiologists at the annual meeting in March 1986. *Dr. T. Moore* attended the 7th International Plant Lipid Conference in Davis, California. *Dr. S. C. Tucker* is the new President-elect of the Botanical Society of America for 1986–87. He was also invited to speak at the AIBS meeting at the University of Massachusetts on "Biology of the Spadix." In June 1986, *Dr. Tucker* gave an address to the Second International

Legume Conference on "Evolutionary and Biological Implications of Floral Organogenesis." *Dr. B. Williamson* has been elected to the Executive Committee of the Organization for Tropical Studies.

Louisiana State University, Department of Botany. *Dr. James V. Moroney,* currently a postdoctoral Fellow in the Department of Biochemistry, Michigan State University, has joined the department as an Assistant Professor. *Dr. Moroney*'s research centers on the study of photosynthesis in higher plants and algae. *Drs. Elizabeth Zimmer* and *Nikolaus Fischer* have been appointed as Adjunct Faculty. *Dr. Zimmer* is an Assistant Professor in the Dept. of Biochemistry and is investigating the evolution and phylogeny of land plants as reflected in the genes encoding ribosomal RNAs. *Dr. Fischer* is a Professor in the Department of Chemistry and is interested in plant secondary metabolites. *Dr. Meredith Blackwell,* Associate Professor of Botany recently received funding from NSF for a study on "The Development, Taxonomy and Host Relations of *Thaxteriola* and its *Pyxidiophora* Teleomorph." The Department was the host department for the Annual Meeting of the American Society of Plant Physiologists. Some 960 scientists attended the meeting in June 1986.

Mississippi

Mississippi College, Department of Biological Sciences. *Dr. Theodore Snazelle* has recently been elected President of the American Daffodil Society. *Dr. Snazelle* is an authority on daffodil diseases and has been very active in the Society for several years. *Dr. Bill Stark* will be on sabbatical and will attend the International Stonefly Conference in Australia where he will present a paper and do research on the flies "down under."

Mississippi University for Women, Division of Science and Math. *Dr. Preston McKee* has accepted a position at Louisiana College beginning with the 1986–87 academic year. *Dr. McKee* is a Associate Professor of Biology and a microbiologist. *Dr. Jon Fortman* was selected "Faculty Member of the Year" by the MUW Alumnae Association and Student Government Association.

North Carolina

North Carolina State University, Department of Horticultural Science. The following faculty were promoted to Professor: *Dr. Frank Blazich* and *M. A. Powell.* The following were promoted to Associate Professor: *W. E. Hooker* and *Drs. M. M. Peet* and *Katie B. Perry.* The following faculty have been elected or appointed to the following positions: *Dr. Joseph W. Love,* President of the Southern Region of the American Society for Horticultural Science; *Dr. M. M. Peet,* Associate Editor for Agronomy Journal; *Dr. August A. DeHertogh,* Executive Committee of the Southern Region of the American Society for Horticultural Science; *Dr. K. B. Perry,* Chairman of the National Agricultural Research Institute's Panel on Agricultural Meteorology. Inducted into Gamma Sigma Delta, National Honor Society of Agriculture, were Drs. *W. E. Ballinger* and *F. A. Blazich. Dr. Tom Monaco* was awarded the N.C. Fresh Vegetable Growers Association Leadership Award. *Mr. Will Hooker* received the 1986 Merit Award from the N.C. American Society of Landscape Architects for his landscape design of Brightleaf Square, Durham, N.C. The Southern Region of the American Society for Horticultural Science made the following awards to faculty: the L. M. Ware Research Award to *Dr. D. M. Pharr et al.* for the paper entitled "Leaf carbohydrate status and enzymes of translocate synthesis in fruiting and vegetative plants of *Cucumis sativus L.*"; six of the nine awards for Outstanding Extension Publications to *Drs. A. R. Bonanno* and *T. J. Monaco* for the "Weed Attack Manual," to *Dr. D. C. Sanders* and *Mr. G. R. Hughes* for "Production of Commercial Vegetable Transplants," to *Dr. V. P. Bonaminio* (ed.) for "North Carolina Nursery Manual," to *Drs. K. M. Williams* and *E. B. Poling* for "North Carolina Fruit Grower Newsletter," to *Drs. L. G. Wilson, J. M. Cannon,* and *W. W. Collins* for "The Certified Sweet Potato Seed Program in North Carolina," and to *Drs. E. B. Poling, A. R. Bonano, K. B. Perry et al.* for "Commercial Strawberry Production in North Carolina." The following faculty are on sabbatical leaves: *Dr. Barclay Poling* to Cornell University for research with SCAMP, *Dr. Denny Werner* to the University of Florida, Fruit Crops Department for research in DNA methodology, and *Dr. Wanda Collins* to Peru for sweet potato research.

Highlands Biological Station. A program of grants-in-aid and scholarships is announced for support of field-oriented research in biology dealing with the biota of the Southern Appalachians. Support is available for both graduate and postdoctoral positions. The deadline for receipt of proposals for 1987 is 1 March 1987. Additional information and application forms can be obtained by writing Executive Director, Highlands Biological Station, P.O. Box 580, Highlands, North Carolina 28741.

North Carolina State University, Department of Zoology. *Dr. Jeffrey M. Hinshaw* has accepted an Assistant Professor position in the department. His area of expertise is aquaculture. He will conduct extension activities and research on trout aquaculture at the Mountain Horticultural Research Station in Fletcher, N.C.

East Carolina University, Department of Biology. *Mark M. Brinson* has received an award of $125,000 from the U.S. Fish and Wildlife Service in supplemental funds for a project entitled "Nutrient Cycling and Fishery Utilization of High Marsh Habitats in Coastal North Carolina." Funding of this project totals $300,000 over a three-year period.

South Carolina

College of Charleston, Department of Biology. *Dr. Robert K. Johnson* has assumed the position of Director of the Charleston Higher Education Consortium Graduate Program in Marine Biology. *Dr. Johnson* is a prominent ichthyologist who is coming to Charleston from the Field Museum of Natural History in Chicago. *Dr. Carl Whitney* will be joining the faculty in the Fall of 1986. *Dr. Whitney* will serve as Coordinator of Introductory Biology Laboratories. His former position was at the University of British Columbia.

University of South Carolina, Columbia, Department of Biology. *Dr. Charles F. Duggins, Jr.* from Cameron University in Lawton, Oklahoma has joined the faculty as Visiting Associate Professor of Biology. His primary responsibility is to direct the non-major audio-tutorial program of instruction. The University Herbarium has recently acquired the herbarium of Coker College. This herbarium of over 6000 specimens dates from 1907 and contains the collections of ferns and fern allies by *Velma Matthews*, the voucher specimens for the work by *Budd E. Smith* on the flora of Darlington County, SC and collections of *William C. Coker, Robert T. Clausen*, and *George P. Sawyer*. The Coker College Herbarium will be maintained separately from the USC collection until the specimens are repaired and annotated; however, it is available to visiting researchers and for loans. *Dr. David Dwight Husband*, Associate Professor of Biology, died on 21 April 1986. *Dr. Husband* developed the audio-tutorial program for non-major biology instruction at the University. He has been an active member of ASB since 1970 and served on the Local Arrangements Committee for the 1986 annual meeting.

Tennessee

Austin Peay State University, Department of Biology. The Department has been designated as a Center of Excellence for the Study of Flora and Non-Game Fauna of Land Between the Lakes by the Tennessee Higher Education Commission. This Center will bring together scholars and students from various biological disciplines to conduct research on biotic inventories, community structure, rare, threatened and endangered species, and the environment of Land Between the Lakes, a 300 square mile peninsula of mostly forested land located between the impounded Tennessee and Cumberland Rivers. Principal investigiators in the Center are: *Dr. Charles Boehms*, aquatic macroinvertebrates; *Dr. Wayne Chester*, vascular plants; *Dr. Floyd Scott*, herpetological survey; and *Dr. David Snyder*, small-invertebrate communities. *Dr. Benjamin Stone* is director of the Center. Appointments are available for twelve undergraduate and six graduate research assistantships. Four senior research fellow appointments are available to faculty with regional and national prominence in field biology research.

University of Tennessee at Martin, Department of Biological Sciences. *Dr. Jimmy Trentham* was selected for a second time to receive the U.T. Alumni Association Outstanding Teacher Award. *Dr. Trentham* is a microbiologist. *Dr. Andy Sliger* has been appointed Chairman of the Department. The Reelfoot Lake Teaching and Research Center has been renovated to provide a chemistry-type laboratory and additional living quarters for student groups. The center is available for field trip groups. For more information contact *Andy Sliger*, Dept. of Biological Sciences, U.T. Martin, Martin, TN 38238. (901) 587-7184.

Virginia

University of Virginia, Charlottesville, Department of Biology. *Professor James N. Dent* and Associate Professor *Richard D. McKinsey* retired as of May 1986. *Michael P. Timko* has been hired as Assistant Professor in plant biology effective September 1986.

ABOUT MUSEUMS AND BOTANICAL GARDENS

Kentucky

Museum of History and Science, Louisville. The Museum's Education Department has nominated Ms. Laura Hansen of Sacred Heart Model School and *Mr. Tony Peake* of the Brown School in Louisville to the Teacher Honor Roll for National Science Week. Humana has donated $100,000 to the Museum earmarked for a permanent exhibit entitled "Heart, Health, and Circulation." The exhibit will occupy the third floor of the Museum. The newest permanent exhibit, "Quiet Lightning," may be art, science, or a fugitive from Frankenstein's laboratory. It's all in the way you look at it. The original Bartholdi family bronze figure, "Liberty Enlightening the World," was loaned to the Museum by its owners, the employees of Philip Morris Companies Inc. The statue was on public display at the Museum during June 1986. The 4 foot 5½-inch sculpture is the largest bronze model of the Statue of Liberty and originally belonged to *Frederic-Auguste Bartholdi,* the statue's sculptor. It was kept in the Bartholdi family until it was purchased in late 1985 by *Mr. Joseph F. Cullman III,* Chairman Emeritus of Philip Morris. Cullman, a cousin twice removed of *Emma Lazarus,* whose immortal poem "The New Colossus" is closely associated with the Statue of Liberty, then donated the sculpture to Philip Morris employees. The Museum has been chosen as the only museum site to test GEMS—Great Explorations in Math and Science—along with major school systems throughout the country. GEMS, developed by the *Lawrence Hall* of Science at the University of California, Berkeley, are innovative, hands-on, proven effective lessons designed to teach math and science to students at a variety of grade levels. The Fall 1986 Exhibit Calendar for the Museum is as follows: October: "Raceways"—motion, velocity, acceleration, and hands-on physics concepts will be demonstrated; November: "Toys, Trains, and Dolls"—a holiday celebration of toys to admire and explore; December: "Visions of Sugarplums"—special seasonal programs for grades pre-K through 1; January 1987: "Pioneers in Sound and Communication"—hands-on experiments include whisper dishes, voice pictures, pitch matching, and music making; February 1987: "Gravitram"—a Rube Goldberg-type device demonstrating kinetic and potential energy. Bouncing balls seem to defy gravity as they bound up tunnels, transfer energy back and forth and race overhead; March: "Return of the Dinosaurs"—these prehistoric beasts will return to stalk the earth in Louisville again. Four new faces plus *Tyrannosaurus Rex* will gather over the 10-weeks exhibit.

Louisiana

Lafayette Natural History Museum. From September 7 through 7 January 1987, the Museum will have "The Louisiana Prairie" on exhibit. Planetarium Programs entitled "The Last Question" and "The Sky Tonight" will be displayed from 15 July through 19 October, and 21 October through 30 November respectively. The Acadiana Park Nature Station & Trail will present a variety of programs each weekday from 9 to 5 and from 11–3 on the weekends.

ASSOCIATION OF SOUTHEASTERN BIOLOGISTS

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The ASB BULLETIN

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and society information.

COVER

It is hoped the new black on white cover format will be pleasing to all and impart a new and enhanced look to the Journal.

TIME AND PLACE OF FUTURE MEETINGS

1987	April 8–11	University of Georgia, Athens (50th Anniversary)
1988		Co-Hosts: University of Southern Mississippi and Gulf Coast Research Laboratory, Biloxi, Mississippi

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PHYSIOGRAPHIC ANALYSES OF THE LONGITUDINAL DISTRIBUTION OF FISHES IN THE RAPPAHANNOCK RIVER, VIRGINIA

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ABSTRACT

Analyses of the effects of elevation, gradient, and stream order on the longitudinal distribution of fishes in the Rappahannock River revealed statistically significant interrelationships between these factors. Numbers of species increased with decreasing elevations and gradients from the headwater tributaries in the Blue Ridge to the mainstream at the Fall Line. Generally, species diversity increased with increasing level of stream order. Eighty-five species of fishes (62 freshwater and 23 marine) and five hybrids, identified in 365 collections, accounted for the increased diversity in populations from the mountains to the Piedmont. Replacement of species, especially marine forms, characterized the community in the tidal reach below the Fall Line. The freshwater fish fauna in the Rappahannock River is more similar to that of the York River than to any of the other three major Virginia tributaries of Chesapeake Bay.

INTRODUCTION

Numerous methods have been used to classify lotic systems on the basis of longitudinal distribution or succession of stream organisms (Whiteside and McNatt 1972). Classification by stream order (Horton 1945) has been most widely accepted. Hynes (1970) devoted an entire chapter on stream order in his book on classification of streams by fish distribution. He also considered other ancillary factors (*e.g.* elevation, pool and riffle habitats, substrate composition and physiochemical parameters) as means of classifying stream types and delineation of ichthyofaunal distributions in river systems. Horowitz (1978) was able to demonstrate the relationship of river discharge to diversity patterns of fishes in 15 rivers of the Mississippi River system.

Longitudinal succession in lotic waters is the change in abundance and/or diversity of species from the headwaters to the mouth of the river. Longitudinal addition of stream fishes has been shown in several different geographic regions. Kuehne (1962), Harrel *et al.* (1967), and Sheldon (1968) classified streams based on distribution and diversity of fishes. Whiteside and McNatt (1972) and Jenkins and Freeman (1972) related the abundance and longitudinal distribution of fishes to physical and chemical characteristics of their habitats. Lotrich (1973) postulated that a stream order represents a biological unit that can be subdivided into physical microhabitats. Evans and Noble (1979) considered stream depth and soil quality to be of greater significance in the longitudinal distribution of fishes than stream order. All of these studies support the concept that the longitudinal increase in numbers of species is due to increases in habitat complexity as the longitudinal distance increases from the stream source.

Changes in species composition in longitudinal stream succession may be the result of addition of species, replacement or both. Burton and Odum (1945) believed replacement rather than addition of species accounted for longitudinal succession in the fish fauna in mountain streams in Virginia. They also contended that changes in elevation of the five creeks in their study had a greater impact on fish species composition than did any other factor. Cicerello and Butler (1985) reported that the distribution of fishes in the upper Cumberland River was by the addition of species in the middle stream section and replacement of species in the lower section but did not elaborate on the cause of the difference in the pattern. Matthews (1986) concluded that after studying 23 small streams in the eastern and central United States, diversity of fishes varied with different microhabitats rather than with changes in stream order.

The present study examines the relation of the longitudinal distribution of fishes to physiographic parameters, stream order, elevation, and gradient in the Rappahannock River, Virginia.

STUDY AREA

The Rappahannock River system extends 340 km in a general northwest to southeast direction through the northern third of Virginia. The basin varies in width from 16 to 80 km and includes a drainage area of 7032 sq km, about 6.8% of the total land area in the state (Va. Div. Water Resources 1970a). The river orginates along the eastern slope of the Blue Ridge at an elevation above 1000 m and terminates in Chesapeake Bay at Deltaville. Major physiographic provinces from west to east are Blue Ridge, Piedmont and Coastal Plain.

The gradient of the river is approximately 6 m/km. Average discharge near the Fall Line is 45.5 m^3/sec; average annual precipitation ranges from 92.3 cm in the headwaters to 118 cm near the mouth; and average annual temperatures in the basin range from 8.8 C in the Blue Ridge to 14.4 C in the Coastal Plain (Va. Div. Water Resources 1970b).

The American Viscose cellophane plant at Fredericksburg is the only major industrial plant on the entire river (Va. Div. Water Resources 1970a). Approximately 52% of the basin is forested, 35% cropland and pasture, 7% mostly forested Federal lands, 4% idle land and wildlife areas, and 2% urbanized (Va. Div. Water Resources 1970a).

MATERIALS AND METHODS

Data from 365 fish collections made by 35 different collectors in the Rappahannock River from 1895 to 1983 were used in the study. Eight percent (29) were made prior to 1940; 92% (336) were made from 1940 to 1983, 84% of these occurred after 1962. Collection data and disposition of specimens are available

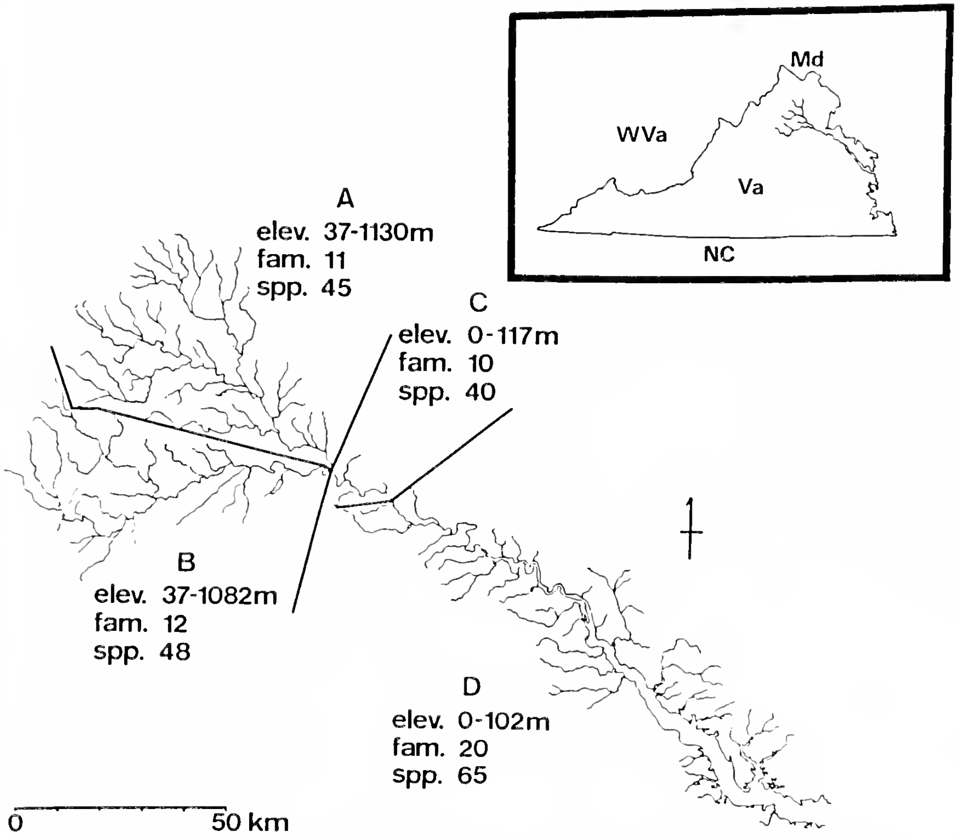

Fig. 1. The Rappahannock River drainage, Virginia with elevation and number of fish families and species per Zone. A—Rappahannock R. from headwaters to confluence with Rapidan R.; B—Rapidan R.; C—Rappahannock R. from confluence with Rapidan R. to Fall Line; and D—Tidal Rappahannock R.

upon request. Collecting techniques included seining, trawling, electrofishing, and angling.

The river is naturally divided into four physiographic zones (Fig. 1). Zone A is the Rappahannock River drainage from the headwaters to the confluence with the Rapidan River, Zone B includes the Rapidan River and its tributaries, Zone C is the Rappahannock River system from the Rappahannock-Rapidan confluence in the central Piedmont Province to the Fall Line, and Zone D is the tidal portion of the river and its tributaries from the Fall Line to the Chesapeake Bay.

Distributional data were analyzed using stream order, elevation and gradient as variables (Table 1). These parameters were used to compare the distributions of fishes within and among streams of the four physiographic zones of the river (Fig. 1). Stream orders were established following the methods of Horton (1945) with one exception. Intermittent streams were classified as first order. Order did not increase with the confluence of another intermittent or permanent stream. In our study they were seasonal and did not have a permanent fish community. Stream orders were determined by tracing the drainages on U.S. Geological Survey topographic maps (1:24,000 scale). Map contour lines were used to establish the elevation of each collecting location. The same technique was used to establish gradient values for each stream order per physiographic zone. Stream orders were established according to Hynes (1970). First order streams have no tributaries, but when two meet they become a second order stream. Two second order streams meet to form one of third order and so on, with the proviso that acquisition of extra tributaries of an order lower than that of the receiving stream does not increase the order of that stream.

Species diversity was analyzed by stream order, elevation and gradient with multiple regression analysis (Steel and Torrie 1960). Duncan's Multiple Range Test (Steel and Torrie 1960) was used to test for differences among average numbers of species in the six stream orders. Jaccard's Coefficient was used to compare species composition by stream order and elevation among and between all zones of the river (Sneath and Sokal 1973). Additionally, the similarity of fish fauna in the Rappahannock River was compared with that of the Susquehanna, Potomac, York, and James river drainages as described by Stauffer *et al.* (1982). Nomenclature followed Bailey *et al.* (1970).

RESULTS

The Rappahannock River system is composed of six stream orders (Table 1). Five stream orders (1, 2, 3, 4, and 5) were identified in both Zones A and B. Zone C had three stream orders (1, 2, and 6) and zone D had four (1, 2, 3, and 6). There was negative correlation between elevation and stream order and gradient

Table 1. Stream order, elevation and gradient means and ranges for the four zones of the Rappahannock River drainage.

Zone-stream order	Elevation (m)		Gradient (m/km)	
	$\bar{x}$	Range	$\bar{x}$	No. collections
A				105
1	223	104–610	8.9	22
2	184	75–488	12.9	39
3	158	63–366	7.3	30
4	109	88–139	7.3	9
5	79	70–87	0.2	5
B				108
1	416	139–914	24.0	28
2	210	67–786	7.2	43
3	137	64–232	7.6	15
4	107	72–119	5.8	18
5	58	55–61	5.3	4
C				20
1	69	43–85	—	8
2	41	21–46	—	6
6	9	3–21	0.2	6
D				132
1	40	9–210	—	14
2	17	3–61	—	23
3	8	0–38	—	25
6	0	—	—	70
Total				365

Table 2. Significant correlation coefficients ($r \geq 0.707$; $P = 0.05$) among physiographic parameters and number of species in the Rappahannock River drainage.

Parameter	Order	Elevation	Gradient	Species
Order	1.0000	−0.9886	−0.9424	0.3144
Elevation		1.0000	0.8964	−0.3634
Gradient			1.0000	−0.3908
Species				1.0000

and stream order (Table 2). Elevation and gradient were positively correlated. All three factors contributed significantly to species diversity (Table 2).

Eighty-five species, five hybrids, and two subspecies representing 15 orders and 24 families of fishes were recorded in the collections (Table 3). The five hybrids were combinations of cyprinid species. Sixty-two species were freshwater forms and 23 were primarily marine. The number of species per zone was 45(A), 48(B), 40(C) and 65(D). Cyprinids (22 species) and centrarchids (12 species), the most speciose families, accounted for 40% of the total fish fauna. None of the remaining 22 families were represented by more than six species.

Rhinichthys atratulus was the most frequently collected species, occurring in 42% of all collections. Other frequently encountered species were *Etheostoma olmstedi vexillare* (32%), *Clinostomus funduloides* (30%), *Notropis cornutus* (28%), *Semotilus corporalis* (27%), and *Notropis analostanus* (26%). No other species was represented in more than 25% of the collections.

Lepomis macrochirus was the most nearly ubiquitous of all species as it occurred in all zones and streams except first order streams of Zone B (Table 3). Species present in all but two stream orders (of all zones) were: *C. funduloides* (A5, C6), *N. analostanus* (A1, C1), *Catostomus commersoni* (B1, D6), and *Lepomis auritus* (B1, C1) (Table 3). Species present in all but three stream orders (of all zones) were: *Notemigonus crysoleucas* (B1, C2, C6), *Notropis procne* (B1, C1, D6), and *S. corporalis* (B1, C1, C2). Fourteen marine species and eight freshwater fishes were reported from only one zone and one stream order (Table 3).

The range of the number of species per zone was: Zone A, 25–40; Zone B, 13–41; Zone C, 15–32; and Zone D, 22–47. The number of species ($\bar{x} = 18.8$) in all first order streams, regardless of zone, was significantly lower than those ($\bar{x}$ range 25–41) of all other orders (Table 4). Conversely, numbers of species in stream orders, 6 ($\bar{x} = 39.5$) and 3 ($\bar{x} = 41$) were alike, as both were significantly higher than in other orders (Table 4).

The similarity in numbers of species among orders of different zones was highly variable (Table 3). The diversity values in stream orders 2 through 5 in Zone A were like those of Zone B. Rapidan (Zone B) order 1 (elevation 416 m) possessed only 13 species, one-half that of the upper Rappahannock (Zone A) order 1 (elevation 223 m). The number of species in stream order 6 of Zone C was related to that of order 2, Zone D. The number of species in stream order 2 of Zones A and B was twice that of the same order of Zones C and D. However, stream order 5, the mainstream of Zones A and B, had half the number of species occurring in stream order 6, Zone D.

Jaccard Coefficient index values, among stream order 1 and all other stream orders, decreased progressively with increasing stream order, except for B1 versus

Table 3. Percent occurrence of fishes by stream order within physiographic zones in the Rappahannock River.

Zone	A					B	
Stream Order	1	2	3	4	5	1	2
Number: Species	25	38	40	32	27	13	40
Number: Collections	22	39	30	9	5	28	43
Fishes	Percent Occurrence Per Stream Order*						
Lampetra appendix			3				9
Petromyzon marinus							
Acipenser oxyrhyncus							
Lepisosteus osseus							
Anguilla rostrata	14	15	3		20	21	12
Alosa aestivalis							
Alosa mediocris							
Alosa pseudoharangus							
Alosa sapidissima							
Brevoortia tyrannus							
Dorosoma cepedianum							
Anchoa mitchilli							
Salmo gairdneri			3				2
Salmo trutta	5	5	7				5
Salvelinus fontinalis	41	23	10			86	42
Umbra pygmaea							
Esox americanus							
Esox niger		5	10		20		7
Carassius auratus							
Clinostomus funduloides	45	62	60	44	20	18	46
Cyprinus carpio					20		
Ericymba buccata		8	17	22	20		
Exoglossum maxillingua	5	18	17	22		4	9
Hybognathus regius					20		
Nocomis leptocephalus		8	13	11		11	35
Nocomis micropogon	14	41	53	89	60	4	21
Notemigonus crysoleucas	14	3	10	11	20		3
Notropis amoenus		8	13	44	20		5
Notropis analostanus	14	23	43	89	80		16
Notropis bifrenatus							2
Notropis cornutus	18	44	63	67	40		40
Notropis hudsonius					60		
Notropis procne	18	31	47	67	80		19
Notropis rubellus		8	20	44	20		5
Phoxinus oreas							28
Pimephales notatus	14	18	4	22	40		
Rhinichthys atratulus	86	85	63	22		54	74
Rhinichthys cataractae	27	28	57	33		11	58
Semotilus atromaculatus	18	21	7	11		4	2
Semotilus corporalis	27	44	43	78	60		28
C. funduloides × *N. micropogon*		3					
N. leptocephalus × *P. oreas*							2
N. micropogon × *N. leptocephalus*				11			12
N. cornutus × *N. rubellus*			7	11			
N. cornutus × *C. funduloides*							

Table 3. Extended.

B			C			D				
3	4	5	1	2	6	1	2	3	6	
38	31	23	15	17	32	22	33	45	47	Total
15	18	4	8	6	6	14	23	25	70	365
					Percent Occurrence Per Stream Order*					
7					17					2
7	6				17					1
									1	1
								4		1
	6				67	21	13	32	20	15
								12	67	13
									4	1
							4	4	64	13
									14	3
									50	10
								4	7	2
								4	3	1
										1
										2
										17
7						14	4	12		2
							4	12		1
3					17	7	9	12	1	5
									1	1
26	17		50	67		50	9	4	1	30
									9	2
	11									4
33	22	25							3	9
7					17	7	4	16	26	7
47	67	25	38	50	17					15
67	67	75			67					23
13	6	50	13			57	43	56	9	15
40	33	50			17					8
67	72	100		17	100	14	9	24	10	26
										1
87	83	100	13	33	33				1	28
		75		17	33	14	4	4	73	18
67	67	100		17	33	7	4	12		22
40	67	100	17	33						11
13			13							4
		25								5
53	6		63	67		57	22	8		42
60	61				17					24
		75	75	50		7	4	4		9
67	72	25			50	36	13	12	1	27
										1
										1
13	39									4
	11									1
									1	1

Table 3. Continued.

Zone	A					B	
Stream Order	1	2	3	4	5	1	2
Number: Species	25	38	40	32	27	13	40
Number: Collections	22	39	30	9	5	28	43
Fishes	Percent Occurrence Per Stream Order*						
Catostomus commersoni	27	31	10	11	20		26
Erimyzon oblongus	9	8	3				5
Hypentelium nigricans	9	26	30	44			33
Gambusia affinis							
Membras martinica							
Menidia beryllina							
Menidia menidia							
Apeltus quadracus							
Morone americana							
Morone saxatilis							
Acantharcus pomotis							
Ambloplites rupestris		10	33	20			
Centrarchus macropterus							
Enneacanthus gloriosus							
Lepomis auritus	14	18	13	22	20		19
Lepomis cyanellus		3					3
Lepomis gibbosus		15	17	22	40		7
Lepomis gulosus							
Moxostoma macrolepidotum							
Moxostoma rhothoecum					20	14	19
Ictalurus catus							
Ictalurus furcatus							
Ictalurus natalis							2
Icatalurus nebulosus		3	3				
Ictalurus punctatus							
Noturus gyrinus							
Noturus insignis	5	5	3		20		5
Aphredoderus sayanus							
Strongylura marina							
Fundulus diaphanus		3	3	11			
Fundulus heteroclitus							
Fundulus majalis							
Lucania parva							
Lepomis macrochirus	14	10	20	33	20		14
Micropterus dolomieui	5	3	7	11	40	4	5
Micropterus salmoides		3	3	11			5
Pomoxis nigromaculatus			3	11			
Etheostoma olmstedi[a]							
Etheostoma olmstedi[b]	36	51	67	78	40	4	44
Etheostoma vitreum		5		11	20		2
Perca flavescens							
Percina notogramma	5	8	7				2
Percina peltata		8	10	44	20		
Gobiosoma bosci							
Cottus bairdi	32	31	20	11		14	42
Trinectes maculatus							

* Values rounded to nearest whole number.

[a] *E. o. atromaculatum.*

[b] *E. o. vexillare.*

Table 3. Extended (Continued).

B			C			D				
3	4	5	1	2	6	1	2	3	6	Total
38	31	23	15	17	32	22	33	45	47	365
15	18	4	8	6	6	14	23	25	70	
Percent Occurrence Per Stream Order*										
20	17	25	13	17	17	7	4	8		13
7			25			29	22	44		8
60	44	25			17		4		1	16
							9	4		1
									1	1
								8	3	1
									1	1
					17					1
								12	76	15
									39	7
							13	12	1	2
20	6				17					3
							26	8		2
							13	32	1	3
60	22	75		33	50	21	22	32	10	19
			25	33	17	7				2
7			25	17	17	29	48	52	13	16
							22	4		2
		50			17				3	1
20	22	25								6
								4	56	11
									4	1
			13				13	8		2
7						7	17	12	14	6
					17				57	11
								8		1
20	28				17		13	4		6
							22	28	1	4
									1	1
7								8	16	5
								4		1
								4		1
								4		1
13	11	25	63	50	17	29	52	44	7	19
26	17	50			33			8	3	7
7			13	17	17	7	13	16	11	7
						7	4	8	6	3
					17	43	39	48	60	19
87	61	100		33	83	21				32
7	50				17					4
								24	21	6
26	33	25			17		4			6
20	44	50			50					7
									1	1
40	56		13	17						18
									3	1

Table 4. Results of Duncan's multiple range test of mean number of species per stream order in the Rappahannock River drainage. Means ($\bar{x}$) underscored by the same line are not significantly different at $P \leq 0.05$.

	Order					
	1	5	4	2	6	3
$\bar{x}$	18.8	25	31.5	32.2	39.5	41

B3 (Table 5). The same test produced comparable decreases for species similarity with decreasing elevations (Table 6).

The similarity of kinds of species was examined in a continuum along the two main channels (A–D and B–D) of the river (*e.g.* A1 vs. A2, . . . , A5 vs. C6 and C6 vs. D6). Jaccard Coefficient Index values increased with increasing stream order (orders 1 to 6) with highest order values occurring at positions 2 and 3 (Table 5).

Replacement of species was substantially more important than species addition in determining species composition in all physiographic regions through the Rappahannock River drainage except at the extremes. Species addition accounted for almost one-half of the species composition of montane and Coastal Plain populations (Table 7).

The Rappahannock River occupies the median position of the five major tributaries of Chesapeake Bay. The freshwater fish fauna in the Rappahannock River, when tested with the Jaccard Coefficient (100×), was more similar to those of the southern tributaries (York River, 81; James River, 72) than it was to those to the north (Potomac River, 66; Susquehanna River, 55) (Table 8).

Table 5. Jaccard Coefficient (100×) species composition similarities between stream orders (numerals) in zones (letters) of the Rappahannock River drainage.

		1				2			
		A	B	C	D	A	B	C	D
1	A	100	41	29	38	67	64	35	35
	B		100	22	17	37	33	25	09
	C			100	37	33	38	52	26
	D				100	58	40	50	62
2	A					100	77	57	37
	B						100	36	36
	C							100	28
	D								100
3	A								
	B								
	D								
4	A								
	B								
5	A								
	B								
6	C								
	D								

DISCUSSION

The Rappahannock River, because of its variable physiography from that of montane to Coastal Plain, presents a wide variety of habitats to fishes. It lends itself particularly well to the study of the influence of the physiographic parameters, stream order, elevation and gradient, on longitudinal distribution of stream fishes.

Data from the entire Rappahannock River (ignoring physiographic boundaries) were analyzed by a comparison of sequentially increasing stream orders and decreasing elevation from the headwaters to the mouth of the river. Jaccard Coefficient Index values of species composition increased with increasing stream order, with highest values in those orders occurring at locations three or four. Numbers of species have been correlated with habitat diversity and shown to increase with increasing stream orders, and consequently lower elevation, as habitat diversity increases. Lotrich (1973) concluded that stream order and species diversity were correlated and therefore stream order may in reality be a valid ecological unit. Hence, it is a natural physiographic entity. He described stream order as a biological unit that can be divided into microhabitats (*e.g.* riffles, pools, type of substrate) and that increases in numbers of species proceeds by discrete units of stream order. After studying longitudinal distributions of fishes in small streams, Matthews (1986) came to the conclusion, "the lack of relation between species and stream order reflects adaptation to local conditions," and that fish faunas differ as much within as between adjacent stream orders. Zone A (upper Rappahannock) and Zone B (Rapidan), where relief was great, had the largest number of freshwater species and greatest diversity of feeding types. The effect of gradient was most pronounced where the number of species in stream order 1, Zone B, of the Rapidan River (24 m/km, 13 species) was compared with the same order in Zone A of the Rappahannock River (8.9 m/km, 25 species). This difference is a reflection of the rate of discharge variability and velocity, which is

Table 5. Extended.

3			4		5		6	
A	B	D	A	B	A	B	C	D
64	48	23	53	59	40	50	36	18
30	25	09	30	35	18	24	15	07
28	30	20	32	22	17	19	17	11
54	40	46	37	27	40	28	38	28
85	68	30	68	65	52	50	53	23
73	65	27	57	58	47	48	51	20
36	35	21	47	35	33	38	36	14
38	37	66	28	26	30	24	33	34
100	69	29	72	62	50	48	51	25
	100	30	67	74	52	46	60	24
		100	25	19	26	17	24	44
			100	79	54	56	48	22
				100	60	57	56	17
					100	51	55	24
						100	55	24
							100	26
								100

Table 6. Jaccard Coefficient (100×) species composition similarities between elevations (m) in the Rappahannock River drainage.

Elev. (m)	914	609	457	305	274	244	213	183	152	122	91	61	30	0
914	100	50	15	17	24	6	6	3	4	2	2	3	1	0
609		100	25	29	24	14	9	8	8	6	4	5	3	2
457			100	53	38	35	23	30	21	20	15	15	9	3
305				100	39	35	22	29	22	19	15	15	8	4
274					100	28	19	24	18	14	12	14	7	2
244						100	28	37	30	27	22	18	11	4
213							100	37	33	31	25	21	16	10
183								100	43	41	32	25	19	9
152									100	38	32	24	19	9
122										100	30	22	20	11
91											100	23	25	13
61												100	19	10
30													100	25
0														100

directly related to the degree of gradient, thereby reducing diversity of habitats. Horowitz (1978) emphasized the significance of increased headwater variability, pointing out headwater diversity was lowest in rivers with the most variable headwaters.

Unlike the upper Zones, A and B, where the greatest habitat diversity and number of species occurred in stream orders 2 and 3, the greatest number of habitats and number of species were found in mainstream order 6 (Zone C). When euryhaline forms were included, Zone D, particularly order 6, possessed the greatest number (65) of species, about one-third more than the next highest composition (48) Zone B. Collection records indicated two euryhaline species (*Anguilla rostrata* and *Fundulus diaphanus*) in Zone A and B, 3 (*Petromyzon marinus, A. rostrata,* and *Apeltus quadracus*) in Zone C, and 21 in Zone D.

The greater percentage of species composition by replacement rather than addition is reflected in steeper gradient streams of the upper Blue Ridge. The similar significance of replacement in Coastal Plain, at the lower extreme of the drainage, is a result of lower gradients, larger habitats (Cicerello and Butler 1985), and unique to our study, salt water intrusion.

Table 7. Percent species composition change through addition and replacement of species of fishes in the Rappahannock River drainage from 1st order streams in the Blue Ridge Province to 6th order main channel in the Coastal Plain.

Province	Stream order	Species		Percent	
		Shared	Added	Addition	Replacement
Blue Ridge	1–2	18	12	40	60
Blue Ridge	2–3	41	1	2	98
Upper Piedmont	3–4	36	0	0	100
Piedmont	4–5	28	0	0	100
Lower Piedmont	5–6	26	1	4	96
Fall Line-Coastal Plain	6	16	13	45	55

Table 8. Jaccard Coefficient indices (100 ×) and total, shared, and different freshwater species of fishes in the Rappahannock River compared to those of the Susquehanna, Potomac, York, and James rivers (see Stauffer *et al.* 1982).

	River				
Parameter	Rappahannock	Susquehanna	Potomac	York	James
Total species	63	87	92	55	83
Shared species	—	53	62	52	61
Different species	(n)	(10) 34	(1) 30	(9) 3	(2) 22
Jaccard coefficient	100	55	66	81	72

The freshwater ichthyofauna of the Rappahannock River is more similar to the York River (the nearest river system) than to the James River to the south and the Potomac and Susquehanna rivers to the north. The Rappahannock and York rivers do not breech the Blue Ridge as do the James and Potomac rivers. The probable origin of most fishes of western Chesapeake Bay tributaries was the Greater Susquehanna River during Pre-Pleistocene glaciation (Jenkins *et al.* 1972; Hocutt 1979). Following glaciation and subsequent melting of the glaciers, the sea level rose and essentially severed the dispersal and exchange routes from the Susquehanna to the previous feeder streams (Thornbury 1965). Consequently, the Rappahannock and York rivers were isolated east of the Blue Ridge and contained species from the Susquehanna. The relatively low similarity of species in the Rappahannock River with those of the present day Susquehanna River is related partially to the latter's acquisition of fishes from the Great Lakes Region (Thornbury 1965). Similarly, the Rappahannock River shares fewer species with the James and Potomac rivers as both have captured streams from river systems west of the Blue Ridge (Hocutt 1979). Subsequent piracies among the James, Potomac, and Rappahannock rivers introduced species into the present-day Rappahannock River and helps to explain the greater faunal similarity of the Rappahannock to the James and Potomac rivers rather than to the present-day Susquehanna River. Introduced exotic species have further magnified the differences in species composition among the five rivers (Stauffer *et al.* 1982).

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NOTES

COMMENTS ON COLOR, SIZE, AND DISTRIBUTION OF THE XANTHID MUD CRAB *GLYPTOXANTHUS EROSUS* IN NORTH CAROLINA AND THE WESTERN ATLANTIC OCEAN

Little is known about the colorful xanthid mud crab *Glyptoxanthus erosus* in the western Atlantic Ocean. This note adds information on natural coloration, large sized individuals from North Carolina and elsewhere, overall distribution, and lowest water temperature tolerated prior to death.

Glyptoxanthus erosus occurs from Cape Lookout, North Carolina southward and along the southeastern coast of the United States, in the Gulf of Mexico to Yucatan, at Cay Sal Banks in the Bahamas (Lemaitre 1984), through the West Indies to St. Croix, Guadeloupe, and south to Belize (Cain 1972; Williams 1965, 1984) (Figure 1 is a composite of North Carolina, literature, and museum locality records). It has been dredged and trawled, during MARMAP surveys of the South Atlantic, from sand substrates located along the South Carolina and Georgia coasts (Fig. 1; Anonymous 1982; Wenner and Read 1981, 1982) at depths from low tide to 281 m, but most frequently between 24 and 200 m (Fig. 1). Captures have also occurred near vegetation and rocky reefs (Williams 1965, 1984; Zingmark 1978).

The most conspicuous feature of *G. erosus* is the highly vermiculated and eroded appearance of all parts of the body shell and legs. This gives it the appearance of a rock overgrown by serpulids or sponges. *G. erosus* is also bright orange-reddish colored throughout, in contrast to other xanthid mud crabs, that are usually tan or brown. Pink prevails along the mid dorsum of the carapace and around the eyes. The tips of the chelae and walking legs, like other xanthids, are brown, whereas the inner surfaces of the chelae are orange. These colors persist in formalin even after 3.0 years of preservation. This coloration differs from the cream-white of preserved specimens noted by Rathburn (1930).

The largest known male *G. erosus* (carapace: 59.2 mm length × 82.9 mm width; UNC-IMS 2795) was trapped in a sea bass pot set 24 November 1983 on a reef in 27 m, 30 km southeast of Bogue Inlet, North Carolina. Prior to this capture the only other large male known from North Carolina had a 60 mm carapace length (cl) × 75 mm carapace width (cw) and was collected on a reef 19 km off Wrightsville Beach, North Carolina in September 1981 (Ann McCrary, pers. comm.). The largest North Carolina female, measuring 47.3 mm cl × 66.7 mm cw (USNM 168866) was caught 5 September 1972, south of Beaufort Inlet Bar, North Carolina, in waters of unknown depth. Williams (1984) reported the largest male and female specimens known to him as 39 mm cl × 54 mm cw and 47 cl × 67 mm cw respectively. Although three other North Carolina specimens are known, captured between 1954 and 1978, all are smaller than those reported here. The largest South Carolina specimen (a female 49.5 mm cl × 62.1 mm cw; USNM 188049), was caught 22 April 1979 in waters of 27 m. In tropical waters, the largest male (52.7 mm cl × 75.8 mm cw; UMML 32: 1103) was collected at Fort Lauderdale Reef, July 1957. The deepest capture (a male 27.5 mm cl × 59.2 mm

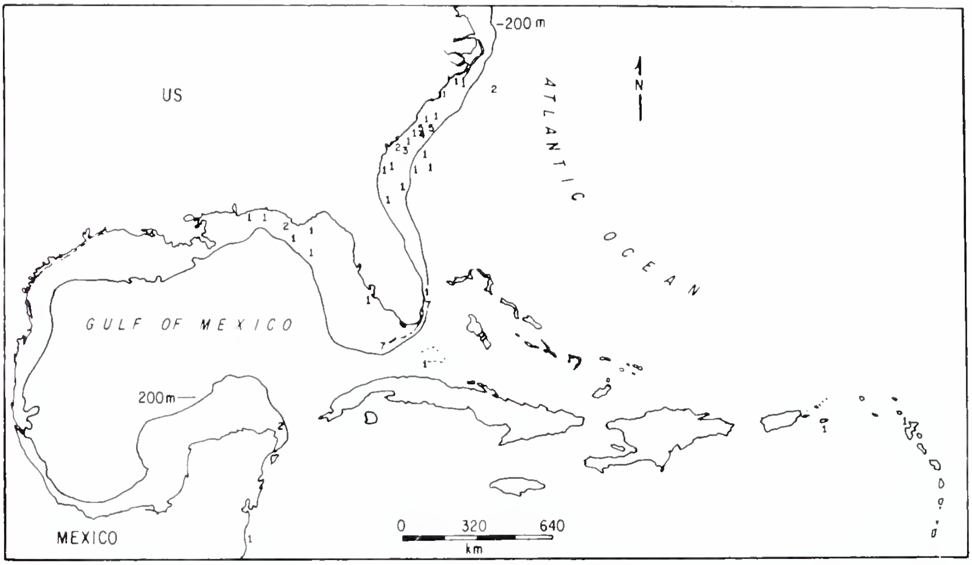

Fig. 1. Distribution of known *G. erosus* collections in the Western Atlantic and Gulf of Mexico. Numbers denote number of specimens at each locality.

cw) was trawled at Nichols Channel (281 m), Cay Sal Banks, Bahamas in 1979 (Lemaitre 1984).

The above data suggest that large *G. erosus* specimens frequent northern waters, in contrast to tropical waters. Such speculation is premature, considering the poorly known distribution, capture, and biology of the crab.

G. erosus frequents ocean waters off North Carolina and elsewhere of 32–35.5‰ salinity (Cain 1972). Natural bottom water temperatures, recorded only for specimens collected from 27–43 m depths, ranged 16.8 to 25.9 C (Wenner and Reed 1982; Wenner, pers. comm. 1984). The large male captured off North Carolina in November 1983 (bottom water temperature was 19 C), maintained in an aquarium supplied with free flowing ambient waters, sustained a low water temperature of 9 C before dying December 1983. Whether death was a natural response to the low aquarium water temperature or a lack of a specific food remains unresolved. Likewise, failure to tolerate natural winter bottom water temperatures lower than 8–9 C (Wenner and Reed 1980) may explain why so few *G. erosus* are known from waters of 200 m depths north of South Carolina.

ACKNOWLEDGEMENTS

Dr. A. B. Williams permitted examination of all *G. erosus* found at the U.S. National Museum and supplied information on the species. Dr. R. Lemaitre, University of Miami, provided Florida and tropical distribution as well as prepublication Cay Sal Bank information. Dr. E. Wenner, S. C. Marine and Wildlife Resources Center, Charleston, South Carolina and Susan Shipman, Georgia Department, Natural Resources, Brunswick, Georgia, commented on locality data for their respective areas. Dr. Ann McCrary, UNC–Wilmington, North Carolina relinquished information on the second largest North Carolina male specimen and along with Dr. C. Hackney (UNC–Wilmington) reviewed the manuscript. Val and Henry Page produced the figure. Mr. Clyde Cheeks, Emerald Isle, North Carolina captured the largest male. J. Garner typed the manuscript.

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REVIEWS

Cailliet, G. M., M. S. Love, and A. W. Ebeling. 1986. **Fishes. A Field and Laboratory Manual on Their Structure, Identification, and Natural History.** Wadsworth Publ. Co., Belmont, CA. $19.75. 194 p.

The goals of Fishes: a field and laboratory manual on their structure, identification, and natural history are: to compile, in one place, material for students enrolled in an ichthyology course, to reduce the tedium of copying and assembling a multitude of hand outs, and to reduce the need to search a myriad of texts for that material. Initial reading of the manual leaves one unsure as to whether the authors have produced another ichthyology text or a composite text-manual.

The 194 page, 8½ × 11″ manual is divided into three sections: 1) morphology of fishes: form and function, in five chapters; 2) taxonomic characters and identification, variation, and classification, in four chapters, and 3) natural history of fishes, in seven chapters. Literature citations are grouped at the ends of each section, p. 82, 123, and 1983, instead of at the end of each chapter.

Much valuable pagination, that should have been devoted to experiments *e.g.* fin clipping to note which affect swimming, steering, diving etc. analyses of air bladder gas after exposure to different pressures, or do all swim bladders contain gas, are taken up with material that can be found in Lagler *et al.* (1962), Bond (1979) or Moyle and Cech (1982). Perhaps it would have been better to suggest to a lecturer what volumes and papers to assemble rather than still referring him or the student to references he, a university or a small college may not have or be able to obtain *e.g.* Williamse (p. 45), or Journal du Conseil (p. 148).

One serious fault with the manual is that the authors refer to a name, statement on one page and then defer definition etc. for several pages, *e.g.* multivore (p. 21) is finally defined as omnivore on p. 65, lateralis superficialis referred to on p. 44 is not shown in Fig. 4.3 nor mentioned on p. 68 or referenced in the index. Photophores, mentioned on p. 53, are not defined even on p. 65. Several items are not in the index *e.g.* ontogenetic stage p. 54, par. 5, electromorphic characters is in the index but electromorphs p. 91 is not.

The authors also assume that the student, at a particular stage in his development or exposure to fishes and the manual, will be able to answer the question of how does the lateral line work (p. 53) before he has any idea of what it is used for. The same is true for photophore (p. 53), he learns on p. 54. How is the student to know where the electromagnetic organs are on a fish (p. 4) if he doesn't learn about them until p. 54? How does he know where eye cones are (p. 53) until he reads about them on p. 58?

Additional problems exist in relation to several figures. *Splanchnocranium* (p. 32) is not on Fig. 3.5 but 3.8. Standard length (defined p. 89) is not the same as in Fig. 4 (there the problem stems from whether to include the lower jaw or not in the length, see Hubbs and Lagler 1949). The text says one thing in relation to what is included in the lower jaw, Fig. 6.2 illustrates another condition. Material in Table 9.2 is really in Table 9.1.

The authors leave us perplexed as to why a scale from a preserved fish is preferred (p. 13) for age analysis. Also one should be aware that chloral hydrate (formula 7, p. 39) is considered a drug by most state and federal agencies and requires a permit, a time consuming procedure, prior to use. Chapter 10 on nets could be deleted as that information abounds in many treatises (Fao 1964; Kristjonsson 1959; Nielson and Johnson 1984). Also the American Museum of Natural History did, but no longer, produce Zoological Record (p. 101).

The authors are to be commended for including several modern statistical approaches, such as principal component analysis, to treat morphometric and meristic data, sections 2 and 3. However, the assumption that the student will be able to know how to manipulate his data from point a to point z in the formula, *e.g.* Table 13.2, defeats their well meant intentions. It would have been better to show, stepwise, actual use of data.

We commend the authors on taking this giant step in producing a laboratory manual on fishes. The several errors or omissions that occur can be easily rectified with revision.

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Mills, Dick. 1985. **A Fish Keepers Guide to Marine Fishes.** A Salamander Book, Arco Publ., N.Y., NY. $8.95. 117 p.

Twenty superb illustrations and 100 color photographs, 59 of them of fishes, encompass this handy 4¾ × 8¾″ hip pocket sized hardback book. The strength of this book is in the author's thoroughness in discussing the physiology of marine vs. freshwater fishes, how to select the correct size fish to be maintained, along with tank construction, heaters, lighting, filtering systems (including protein skimmers), salinity and pH balance, substrate type, water preparation, foods, and disease prevention.

Of the thousands of tropical fishes inhabiting marine waters, unfortunately only 59 species, representing 21 families, are illustrated. Butterflyfish (18 species) and damselfish (10 species) illustrations dominate. Most other fish families are represented by usually only one representative. Abbreviated comments for each family include the species habitat, length, diet, feeding manner, and aquarium compatibility. A few (2) cold water marine fishes, along with three invertebrates (one a colorful crustacean) are mentioned. Depicted fishes are examples from most oceans of the world. A good index and suggested list of periodicals and books for further reading on species and aquaria conclude the book. While limited in species coverage, this volume is a must for the novice aquarist.

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NEWS

ABOUT THE ATHENS MEETING

The University of Georgia will host the 48th Annual (50th Anniversary) Meeting of the Association of the Southeastern Biologists on 8–11 April 1987. Registration will take place at the Georgia Center for Continuing Education, the host facility for the meeting. The Georgia Center is located on the south side of the University's campus. The paper and poster sessions, exhibits, placement services, and the general session will also be at the Georgia Center. On Wednesday evening, open-houses are scheduled at the Institute of Ecology and within departments of the Division of Biological Sciences with a mixer to follow at the Institute of Ecology. A buffet dinner with entertainment is scheduled for Thursday evening at the State Botanical Garden of Georgia, and the traditional Friday evening banquet will be held at the Georgia Center.

SOCIETIES MEETING WITH ASB IN ATHENS

American Society of Ichthyologists and Herpetologists, Southeast Region
Beta Beta Beta, Southeastern Region
Botanical Society of America, Southeastern Section
Ecological Society of America, Southeastern Chapter
South Atlantic Chapter of the Society of Wetlands Scientists
Southeastern Society of Parasitologists
Southern Appalachian Botanical Club
Southeastern Fishes Council

ATHENS AND THE UNIVERSITY OF GEORGIA

Athens is situated 65 miles northeast of Atlanta in the rolling hills of North Georgia. Incorporated in 1806, the city of Athens was named after the great classical center in Greece. The metropolitan area of Athens contains approximately 155,000 people. The "Classic City" is well known for its array of impressive Greek Revival mansions built by prominent Athenian families during the 1800s. Many of these homes have been restored by individuals, civic organizations, and commercial institutions, and several are open to the public for tours.

Athens is best known, however, as the site of America's oldest chartered state university. The University of Georgia was founded in 1786; today its sprawling campus is home to more than 25,000 students. Undergraduates at UGA comprise more than ⅔ of the student body; professional and graduate students totaled nearly 7,000 last year. Eighty percent of the student body is from Georgia, but students come from all other states as well as numerous foreign countries.

The University's instructional programs are administered through 12 colleges and schools. Master's degrees are awarded in 59 fields, doctorates in 52 fields, and professional degrees in 26 areas. The UGA Library collections contain more than 2.5 million volumes, over 3 million microfilms, and nearly 500,000 maps and aerial photographs. The Association of Research Librarians recently ranked the University's libraries as 30th among 113 facilities included in the rankings.

The University's Division of Biological Sciences has a faculty of 147 teaching and research professors. Graduate programs in the Division provide training in the areas of zoology, botany, microbiology, genetics, and entomology. Courses offered by these departments, as well as others, are available to students enrolled in the Ecology Degree Program. This interdepartmental unit provides students the opportunity to obtain a doctoral degree outside of the traditional departmental mode. The Ecology Degree Program was organized in 1970; to date, the program has graduated nearly 200 students.

The Georgia Center for Continuing Education will serve as headquarters for the ASB meeting. This modern conference facility offers motel accommodations, dining facilities, and meeting rooms.

PRE-REGISTRATION AND REGISTRATION

A PRE-REGISTRATION form is provided with this copy of the bulletin. Your pre-registration will enable us to plan facilities and services to be expected at the ASB meeting. Pre-registration packets and late registration will be at the Georgia Center on Wednesday from 5:00–10:00 P.M. and on Thursday and Friday (see general schedule). Early pre-registration will not only aid us, but will assure your reservation for field trips, special meals, and social events. Only a limited number of tickets for special events will be available at the registration desk.

Please bring your April 1987 **ASB Bulletin** to the meeting. No free copies will be available at UGA. However, copies will be available at $3.00 each.

TRAVEL TO ATHENS AND THE UNIVERSITY OF GEORGIA

Automobile: Athens, Georgia is easily accessible by interstate, U.S., and state highways. The city is situated approximately 20 miles between I-85 (to the north) and I-20 (to the southeast). Consult the maps to be published in the April 1987 **ASB Bulletin** for details.

Bus Service: Athens is served by 3 major bus lines: Greyhound, Trailways, and Southeastern Stages. The Athens bus terminal is located downtown within easy walking distance to the UGA campus.

Air Service: Athens is accessible by air via one commuter air service. Piedmont Commuter offers regularly scheduled flights connecting with all major airlines in Atlanta and Charlotte, North Carolina. Charter air service is also available. The Athens airport is located 3.5 miles from the UGA campus. Transportation from the airport is available by taxi. Rental cars are also available from several operators. Hertz Rent-A-Car is headquartered at the Athens airport; Budget and National have offices in town. For attendees who wish to fly to Atlanta, two private limousine services offer transportation between the Atlanta International Airport and Athens. (Call either Jet-A-Way Limousine Shuttle at 1-800-541-3022 or Ward Limousine Service at 404-353-8099 for prices, schedules, and reservations.) Rental cars are also available at the Atlanta International Airport.

Parking: As on most campuses, daytime parking is limited. A parking ramp is available at the Georgia Center both for guests staying at the Georgia Center and for visitors with other accommodations ($2/day). UGA also has an on-campus shuttle service which stops at the Georgia Center.

ACCOMMODATIONS

Limited housing will be available at the Georgia Center. Other hotels and motels in the area can also accommodate our housing needs. Four places (see*) match Georgia Center rates when all rooms at the center are filled. These facilities also guarantee daily shuttle service to and from the Georgia Center. Be sure to inquire about such rates when you make reservations directly with them.

Georgia Center (Meeting Headquarters) (404) 548-1311 University of Georgia Athens, GA 30602	S: $31 D: $38 130 rooms
Bulldog Inn (404) 543-3611 Highway 441 North (7 minute drive from campus)	S: $24 D: $26 51 rooms
Colonial Motor Inn—Best Western (404) 546-7311 1-800-528-1234 176 North Milledge Avenue (5–10 minute drive)	S: $32 D: $34 70 rooms
Days Inn (404) 546-9750 1-800-325-2525 2741 Atlanta Highway (10–15 minute drive)	S: $32 D: $36 62 rooms
Downtowner Motor Inn (404) 549-2626 1-800-238-6161 1198 South Milledge Avenue (10–15 minute walk to campus)	S: $27 D: $31 70 rooms
Holiday Inn* (404) 549-4433 1-800-238-8000 Broad at Hull Street (5 minute walk to campus shuttle bus)	S: $32 ($31*) D: $40 ($38*) 240 rooms
Howard Johnson's Motor Lodge* (404) 548-1111 1-800-654-2000 2465 W. Broad St. (10–15 minute drive)	S: $33 ($31*) D: $42 ($38*) 100 rooms
Quality Inn/History Village Inn* (404) 546-0410 1-800-225-5151 295 E. Dougherty St. (10 minute drive)	S: $31 D: $38 115 rooms
Ramada Inn* (404) 546-8122 1-800-228-2828 513 W. Broad St. (10 minute walk to campus shuttle bus)	S: $41 ($31*) D: $47 ($38*) 160 rooms
Red Carpet Inn (404) 549-1530 1-800-251-1962 2715 Atlanta Highway (10–15 minute drive)	S: $30 D: $32 48 rooms
Scottish Inns (404) 546-8161 401 Macon Highway (5–10 minute drive)	S: $22 D: $24 52 rooms
TraveLodge (404) 548-3000 1-800-255-3050 3791 Atlanta Highway (10–15 minute drive)	S: $39 D: $44 34 rooms

CAMPING FACILITIES

The nearest camping facilities are about 20 miles from campus in Watson Mill Bridge State Park, Route 1, Box 190, Comer, Georgia 30629 (404) 783-5349. RV sites are available for $7/night; tent sites are $6/night. Reservations are not required.

GENERAL SCHEDULE

WEDNESDAY

Registration: 5:00–10:00 P.M., Georgia Center
Field Trips: 3:00–5:00 P.M. See description of Field Trips and Pre-registration form.
Open-House: 5:00–7:00 P.M., UGA Institute of Ecology and departments within UGA's Division of Biological Sciences
ASB Executive Committee Meeting: 7:00 P.M., Southeastern Society of Parasitologists 7:30–9:00 P.M., Georgia Center
Symposium—Environmental Education: update and teaching of undergraduates: 7:30–9:00 P.M.
Mixer: 7:00–10:00 P.M., Institute of Ecology

THURSDAY

Registration: 7:30 A.M.–5:00 P.M., Georgia Center
Past President's Breakfast: 7:00 A.M., Georgia Center
General Plenary Session: 8:30–9:45 A.M., Georgia Center
Paper and Poster Sessions, Exhibits, and Placement Service: 8:00–5:00 P.M., Georgia Center
Symposia—Host Resistance and Parasite Evasion: 10:00 A.M.–12:00 Noon, Georgia Center
—Terrestrial Biotic Communities of the Southeast: 1:00–4:30 P.M., Georgia Center
Field Trip (Tour Biological Sciences facilities) for Beta Beta Beta: 2:00–4:00 P.M.
Business Meetings: American Society of Ichthyologists and Herpetologists, Southeast Division: 12:00–12:30 P.M.
Southeastern Fishes Council: 12:30–1:00 P.M.
Southeastern Society of Parasitologists: 4:45–5:45 P.M.
Southeastern Chapter of the Ecological Society of America: 4:45–5:45 P.M.
Business-Luncheon Meeting: South Atlantic Chapter of the Society of Wetlands Scientists: 12:30–1:00 P.M.; Southeastern Society of Parasitologists: 12:00–1:00 P.M.
Luncheon: Southeastern Society of Parasitologists: 12:30–1:30 P.M., Georgia Center
Buffet and Entertainment: 6:00–10:00 P.M., State Botanical Garden of Georgia

FRIDAY

Late Registration: 8:00 A.M.–12:00 Noon, Georgia Center
Breakfast and business meeting: Southern Appalachian Botanical Club and Southeastern Section of the Botanical Society of America: 7:00 A.M., Georgia Center
Paper and Poster Sessions, Exhibits, and Placement Service: 8:00–5:00 P.M., Georgia Center
Symposium—Aquatic Biotic Communities of the Southeast: 8:30–11:30 A.M., Georgia Center
ASB Business Meeting: 11:30 A.M.–12:30 P.M., Georgia Center

Beta Beta Beta Luncheon: 11:45 A.M.–1:15 P.M., Georgia Center

Southeastern Chapter of the Ecological Society of America Luncheon: 12:30–1:30 P.M., Institute of Ecology

Symposium—*Fifty Years of Mycology in the Southeast*: 2:00–5:15 P.M., Georgia Center

Field Trips to Snapfinger Woods (2:30–5:00 P.M.) and the Okefenokee Swamp (4:00 P.M. Friday–10:00 P.M. Saturday). See description of Field Trips and Pre-registration form.

Social Hour: 6:15–7:30 P.M., Georgia Center

ASB Banquet: 7:30 P.M., Georgia Center

SATURDAY

Field Trips: Begin at 8:00 A.M., Departures from Georgia Center parking lot.

POINTS OF INTEREST IN THE ATHENS AREA

DOUBLE-BARRELED CANNON—College Avenue at Hancock Avenue. Believed to be the only one of its type in the world, this 1863 relic from the War Between the States now rests at City Hall.

FIRE HALL NO. 2—489 Prince Avenue. Built in 1901 and used as a fire station until 1980, this wedge-shaped building now serves as the headquarters for the Athens Clarke Heritage Foundation. The exterior of the fire station remains unchanged and features an iron balcony. An authentic brass fire pole remains inside the building. (Open Tuesday–Friday, 10:00 A.M.–4:00 P.M.; call Sheila Hackney, 353-1801.)

FOUNDERS MEMORIAL GARDENS AND GARDEN CLUB HEADQUARTERS OF GEORGIA—325 N. Lumpkin St., UGA Campus. Built in 1857 as the home of a University professor, the house has been restored and furnished with appropriate period pieces. The gardens surrounding the house were built as a memorial to the founders of the first garden club in America. (Open Monday–Friday, 9:00 A.M.–12:00 Noon and 1:00 P.M.–4:00 P.M.; 542-3631.)

MEMORIAL PARK—293 Gran Ellen Drive. Operated by the Athens Department of Parks and Recreation, this park has nice walking paths and a small zoo. (Open daily from sunrise to sunset; 546-7972.)

SANDY CREEK NATURE CENTER—170 Old Commerce Road. Offers nature walks and other related activities. (Open Monday–Friday, 8:00 A.M.–5:00 P.M.; Saturday, 12:00 Noon–5:00 P.M.; 354-2930.)

STATE BOTANICAL GARDEN OF GEORGIA—2450 S. Milledge Avenue. A showplace of both native and exotic plants. The Garden comprises 293 acres along the Oconee River; the 10,000 square-foot Visitor Center features a conservatory, teaching laboratories, a gift shop, and a tea room. (Open Monday–Saturday, 9:00 A.M.–4:30 P.M.; Sunday, 11:30 A.M.–4:30 P.M.; 542-6329.)

TAYLOR-GRADY HOUSE—634 Prince Avenue. A National Historic Landmark built in 1845 by General Robert Taylor. (Open to the public for tours Monday–Friday, 10:00 A.M.–3:30 P.M.; call Mrs. Beth Whitton at 549-8688 for reservations; $2.50 charge per person.)

THE TREE THAT OWNS ITSELF—Dearing and Findley Streets. The subject of one of Athens' most enduring legends, it is said that Professor W. H. Jackson deeded the tree and eight feet of land on all sides to itself. The original tree died in 1942, but a sapling from an acorn of the original tree was planted by the Junior Ladies Garden Club in 1946.

UGA ARCH AND OLD NORTH CAMPUS—Broad Street at College Avenue. The Arch, entrance to the UGA campus, is modeled after the Great Seal of the State of Georgia. The three columns of the Arch represent wisdom, justice, and moderation. The Arch and the adjacent iron fence were erected in 1857. The Old North Campus is listed on the National Register of Historic Places.

MUSEUMS

GEORGIA MUSEUM OF ARTS—UGA North Campus. Established in 1945, the museum's permanent collection now contains over 5000 works of art valued at more than $12 million. (Open Monday–Saturday, 9:00 A.M.–5:00 P.M.; Sunday, 1:00 P.M.–5:00 P.M.; 542-3254.)

UGA NATURAL HISTORY MUSEUM—Features seven collections in various locations on campus: Archaeology (Baldwin Hall); Botany Herbarium, Plant Sciences Bldg.); Entomology (Natural History Bldg.); Geology (GGS Bldg.); Mycology (Mycological Herbarium, Plant Sciences Bldg.); Zooarchaeology (Baldwin Hall); and Zoology (Natural History Bldg.). Tours by appointment only. (Contact: Joshua Laerm at 542-3940 or 542-3310.)

VISITOR INFORMATION

ATHENS AREA CHAMBER OF COMMERCE—300 N. Thomas Street. Provides city maps, historical, and tourism information. (Open Monday–Friday, 8:30 A.M.–5:00 P.M.; 549-6800.)

ATHENS WELCOME CENTER—280 E. Dougherty Street. Headquartered in the Church-Waddell-Brumby House, a federal period house built in 1820 for Alonzo Church, who later became president of the University of Georgia. (Open daily 9:00 A.M.–5:00 P.M.; 546-1805.)

TOURS

"*Athens of Old Tours*" feature beautifully restored antebellum homes, scenic gardens, and historic attractions. Tours average two hours. Rates for tours are available upon request, and advance reservations are required. Contact the Athens Welcome Center (546-1805) or the Chamber of Commerce (549-6800) for more information.

FIELD TRIPS

For this 50th Anniversary of the Association of Southeastern Biologists, we are celebrating 50 years of progress. Field trips are designed to introduce the beauty and diversity of Georgia's natural heritage and biotic communities and to reflect the impact of human history on our landscape. The Southeastern Section of the Botanical Society of America is sponsoring field trips 3, 5, 7, and 8. The Chattahoochee National Forest is sponsoring trips 8, 9, 10, and 11. The Southern Appalachian Botanical Club is sponsoring trips 1, 2, 3, 4, 5, 8, 9, 11, and 13. The Southeastern Chapter of the Ecological Society of America is sponsoring trips 5, 6, 7, 8, 9, and 12. All trips will depart from the Georgia Center, and a box lunch will be provided for trips 5–11.

WEDNESDAY, 8 APRIL 1987

1. TOUR OF BOTANY PLANT GROWTH FACILITIES AND THE AGRONOMY RHIZOTRON (3:00–5:00 P.M.)—The greenhouse range covers 15,000 square feet and is divided into 15 rooms, allowing a broad range of growing conditions. Over 25 research projects are presently underway at the facility. Over 500 species are maintained in specialized rooms for tropical and desert plants. Benches are set aside for collections of carnivorous plants, cycads, and fern allies. The clear-span glass and aluminum greenhouses utilize multi-stage environmental controllers, Kool-Cell evaporative pads, Jim-tube radiation, and an automated venting system. The Rhizotron is located nearby in Agronomy facilities. This underground root observation laboratory is one of seven in the U.S., and it allows non-destructive, continuous observation of plants growing in soil in natural conditions. *The greenhouse portion is led by Michael O'C. Moore and the Rhizotron portion is led by Dr. Keith Karnock.*
2. STATE BOTANICAL GARDEN OF GEORGIA (3:00–5:00 P.M.)—The Botanical Garden consists of 293 acres along the Oconee River. Five miles of marked trails lead through the garden. Both exotic and native plants are featured in the garden, and also special areas such as the rose garden, the rhododendron garden, wildflower garden, annual-perennial garden, and a shade garden. The Fred Galle Azalea Collection has 1300+ specimens of 10 species of native azaleas. The Visitor Center and Conservatory is one of the finest horticultural display facilities in the United States. The field trip will include a walk through the Dunson Wildflower Garden and the Orange Trail in the SE part of the garden which follows a spring-fed stream from the Oconee floodplain into the hardwood forest. *Led by the Director, Dr. Roy A. Mecklenburg.*

FRIDAY, 10 APRIL 1987

3. SNAPFINGER WOODS—A MESIC PIEDMONT RAVINE (2:30–5:00 P.M.)—A striking hardwood ravine near Athens provides a haven for the typical woodland wildflowers normally found near Athens. Of interest are the hardwood trees and numerous shrubs common to the middle Piedmont of Georgia. *Led by Dr. Samuel B. Jones, Jr.*

   (*Note*: Field trip for Okefenokee Swamp departs at 4:00 P.M. Friday and returns 10:00 P.M. Saturday. See Field Trip 7 for details.)

SATURDAY, 11 APRIL 1987

4. As #1, except that the greenhouse portion will be *led by Jeff H. Rettig.* The time will be 9:00–11:00 A.M.
5. PANOLA MOUNTAIN STATE CONSERVATION PARK (8:00 A.M.–1:00 P.M.)—Panola Mountain is a large granitic dome harboring many of the 17 taxa endemic to granite outcrops in the Southeast. *Diamorpha smallii, Sedum pusillum,* and *Viguiera porteri* flourish at Panola, where the fragile outcrop communities have been unusually well protected from human disturbance. After traveling to the Park, we will take a 3.5 mile hike to the top of the dome and back. *Led by Dr. Robert Wyatt.*
6. THE LOWER PIEDMONT ECOSYSTEM, CULTURAL AND NATURAL HISTORY (8:00 A.M.–5:00 P.M.)—The trip will examine the cultural features, impact of

European settlement, and natural history of the Lower Piedmont. Points to be visited include: High Shoals on the Apalachee River, site of a former cotton mill; Bostwick, a cotton town where cotton is still grown; Madison, with numerous 1840s homes; the Piedmont National Wildlife Refuge, with typical vegetation; and Jarrell Plantation, for a glimpse of life in the agrarian South. *Led by Dr. Samuel B. Jones, Jr.*

7. OKEFENOKEE SWAMP (4:00 P.M. Friday–10:00 P.M. Saturday)—Okefenokee Swamp in SE Georgia and N Florida is a large, acidic, subtropical blackwater wetland. A rich mosaic of habitat types comprise the Okefenokee, including shrub swamp, blackgum swamp, deep and shallow-water cypress, aquatic macrophytes and open water canals and lakes. Spring visitors will see the ever-present alligator and a diversity or birds, insects (too early for mosquitoes and horseflies!) and flowering plants. This Long Term Ecological Research project is under the direction of Dr. Bernard C. Patten. **The tour is limited to 12 persons.** Registration should be sent by 15 February. Overnight accommodations will be arranged at the Red Carpet Inn in Folkston. Breakfast is on your own. A box lunch will be provided as you tour the swamp by boat. *Led by Dr. Bernard C. Patten and Byron J. "Bud" Freeman.*
8. PANTHER CREEK COVE (9:00 A.M.–4:00 P.M.)—As a result of calcareous deposits, vegetation in Panther Creek Cover is rich and diverse, including *Schisandra,* thousands of ginseng plants, numerous wildflowers and ferns. Bring binoculars and bird books, also. It is necessary to wade across knee-deep Panther Creek at one point, but it is well worth the inconvenience. *Led by Susan L. Sherman and Steven B. Broyles.*
9. SOSEBEE'S COVE (9:00 A.M.–4:00 P.M.)—Outstanding cove flora, with huge buckeyes and yellow poplars. This cove is dedicated to A. Woody, the first forest ranger in the Chattahoochee National Forest. We will drive to the site, then there will be a gentle walk of about 2 miles. *Led by Dr. Levester Pendergrass, Regional Botanist, U.S. Forest Service.*
10. NATIONAL FISH HATCHERY AND DEMONSTRATION STREAM FOR TROUT (9:00 A.M.–4:00 P.M.)—Tour through the fish hatchery at Rock Creek and observe techniques for rearing trout which will be introduced into National Forest streams. Jones Creek was a marginal trout creek which has been improved with added in-stream structures for increasing meanders and other habitat requirements for trout. (You may wish to travel separately and highlight the trip by trout fishing in some of the mountain streams.) *Led by Eddie Morris, Eastern Zone Biologist, Chattahoochee National Forest.*
11. AUTO TOUR FOR OBSERVING FOREST MANAGEMENT TECHNIQUES (9:00 A.M.–4:00 P.M.)—The Chattahoochee National Forest extends from the wild waters of the Chattooga River through the Blue Ridge Mountains into the Cohutta Wilderness and across the ridges and valleys of northwest Georgia. A drive through part of the Chattahoochee National Forest will allow observation of timber harvest, watershed protection, wildlife management, clear-cutting, shelter wood cutting, and proscribed burning and wildlife habitat improvement techniques used by the U.S. Forestry Service. *Led by Ben A. Sanders, Wildlife Staff Officer, Chattahoochee National Forest.*
12. HORSESHOE BEND EXPERIMENTAL AREA (9:00–11:00 A.M.)—Horseshoe Bend is an area beside the Oconee River, just east of the campus. This area has been the locale for agroecosystem research projects operated through the

Institute of Ecology during the last two decades. Current research is concentrating on soil ecology, and tillage and no-tillage agroecosystems. *Led by Dr. D. A. Crossley, Jr.*

13. STATE BOTANICAL GARDEN OF GEORGIA (9:00–11:00 A.M.)—Same as #2. *Led by the Director, Dr. Roy A. Mecklenburg.*

LOCAL ARRANGEMENTS COMMITTEE

Co-chairmen:	Richard Wiegert	(404) 542-3370
	Frank Golley	542-2968
Program:	Gary Meffe	(803) 725-2472
Pre-registration & Registration:	Bruce Wallace	(404) 542-2816
Audio-visual:	Lloyd Logan	542-1511
Exhibits and Exhibitors:	Ivan Roth	542-2680
Field Trips:	Nancy Coile	542-1823
Social Activities:	Elizabeth McGhee	542-3940
Accommodations & Transportation:	Sam Jones	542-1802
Host facility and Meeting Headquarters:	Georgia Center University of Georgia Athens, GA 30602	548-1311

ASSOCIATION AFFAIRS

GUIDELINES FOR POSTER SESSIONS

Poster sessions have been incorporated as a regular means of scientific presentation at the annual ASB meetings. This type of presentation will afford a more informal environment that encourages a direct interchange of ideas and discussion between presenter and audience. Adherence to the following guidelines will help ensure the effectiveness of the poster sessions.

Poster sessions will be held in the Student Union in an area adjacent to other meeting rooms. The specific time and location will be published in the April program issue of the ASB Bulletin. Posters will be organized by subject matter and numbered sequentially in accord with abstract listings in the ASB Bulletin. All posters will be on display for a half day, although authors or co-authors are required to be with their poster papers only during a specified two-hour period. Thumb tacks and tape will be provided. Backing paper or other special display materials should be supplied by each presenter.

Posters should be carefully planned to maximize clarity and simplicity in conveying information. Poster boards of approximately 4′ by 4′ will be available for each paper. Arrange for a heading including title, author(s) and institution to be placed at the top in letters no less than 3 cm high. The body of the poster should include figures, tables, graphs, maps, or photographs displayed in a well-organized and coherent sequence from top to bottom. Do not crowd the display. All materials including text, legends, and captions on figures or tables should be legible from a distance of about 2 m. Each illustration should be captioned. A limited degree of text (letters at least 1 cm high) can be included, but care should be taken not to overwhelm the audience. Authors may choose to post a large typeset copy of the abstract at the top of the poster and include a clear listing of specific conclusions at the bottom.

GUIDELINES FOR RESEARCH AWARDS

ASB Research Awards for Students and Faculty ($500 each). Rules are as follows: (a) Given for especially meritorious paper *presented* by the author(s). Papers must be journal-ready manuscripts worthy of publication. (b) Only ASB members are eligible (this applies to all authors). (c) Papers may be in press but not published prior to the previous annual meeting. (d) Papers are judged by eminent scientists selected by the committee from institutions outside the southeast. Every effort is made to keep authors of submitted papers anonymous. Criteria for the awards are left to the discretion of the judges who may withhold the award or split the award in case of a tie. (e) Papers must be submitted in *triplicate* and in their entirety. (f) Winners will be announced at the annual banquet. The student award is given to the senior author if he/she is a student at the time of presentation. (g) Send to (*faculty*): James W. Ross, Department of Biology, Benedict College, Harden and Blanding Sts., Columbia, SC 29204; (*student*): Dr. Stewart A. Ware, Dept. Biology, William and Mary College, Williamsburg, VA 23185. The original copy will be sent to the sponsor, and the abstract with an announcement will be in the July ASB Bulletin.

The Eugene P. Odum Award—$100 and a plaque given by the Southeastern Chapter of the Ecological Society of America, for the best ecological paper presented by a student.

The paper will be evaluated by a panel of judges at the time of presentation on the following points: (a) Significance of Ideas; (b) Creativity; (c) Quality of Methodology; (d) Validity of Results; (e) Clarity of Presentation.

Eligibility Requirements:

(a) Undergraduate and graduate students are eligible;
(b) The student must be the sole or senior author;
(c) The paper must deal with a clearly ecological topic and should be presented in any of the following sessions: Aquatic Ecology, Plant Ecology, or Animal Ecology;
(d) The paper must be presented in a regular contributed session; papers presented in poster sessions or symposia are ineligible;
(e) The student does not have to be a member of SE/ESA;
(f) The title and abstract of the paper must be submitted to the Award Coordinator by 1 February. This can be a copy of the abstract submitted to ASB 1 December. Submit to: Dr. R. Pulliam, University of Georgia, Department of Zoology, Athens, GA 30602.

The North Carolina Botanical Garden Award—$100 given by NCBG (through the Southeastern Section of the Botanical Society of America and the Southern Appalachian Botanical Club). This is given for an especially meritorious paper presented in the areas of plant systematics, evolution, or conservation. The paper will be evaluated by a panel of judges at the time of presentation, on the following points: (a) significance of ideas, (b) creativity, (c) quality of methodology, (d) validity of results, and (e) clarity of presentation. The actual prize will be presented at the ASB Banquet.

Eligibility Requirements:

(a) All individuals eligible to present a paper at the ASB meetings are eligible for this award.
(b) The paper must deal with the systematics, evolution, species biology (including population biology), or conservation of vascular plants that are native or naturalized to the southeastern United States.
(c) The paper must be presented in a regular Plant Systematics contributed-paper session; papers presented in poster sessions or in symposia are not eligible.
(d) The title and abstract of the paper must be submitted to the Award Coordinator by 1 February 1987. This may be a copy of the abstract submitted to ASB 1 November. Individuals interested in entering a paper for this award should submit the title and abstract to: Dr. George Ramseur, Department. of Biology, University of the South, Sewanee, TN 37375.

"TRAVEL" SUPPORT AWARDS FOR GRADUATE STUDENT MEMBERS OF ASB—*DEADLINE: 1 February.* Limited funds are available to partially defray the expenses of graduate students attending the Annual Meeting. The awards are for lodging and meals only. Departments are urged to provide transportation for their graduate students. Recipients must be members of ASB. Preference will be given to those students giving a paper or poster at the Annual Meeting. The guidelines for application are as follows:

1. Give information as to whether you submitted a title and abstract for a paper or poster.
2. Give a conservative, itemized estimate of meeting expenses excluding transportation.
3. In a paragraph, give a brief history of your education to date; indicate how many years you have been, and expect to be, in graduate school, your major field of interest, publications which have appeared or are in preparation, degree sought, name of major professor, and any other pertinent professional details.
4. Give your source(s) of support while in graduate school; *e.g.* NSF, NIH, USDA, Teaching Asst., Research Asst., etc.
5. Have your major professor or department head provide a letter supporting your application, and enclose this letter with your application.
6. Send application, with supporting letter, *all in triplicate,* to: Dr. Robert E. Daniel, Department of Biology, Murray State University, Murray, KY 42071 (phone: 502/762-2768).
7. Applicants will be notified of the decision of the Committee as soon as possible. Recipients of the award will receive their checks at the time of registration at the meeting.

ASB Enrichment Fund

A new Article to the Bylaws, the Enrichment Fund, proposed at the Columbia, SC meetings but not voted on, will be voted upon at the April business meeting of ASB in Athens, GA. Details of the amendment were published in ASB Bulletin Vol. 33, No. 1, January 1986, pages 13–15. Please familiarize yourself with the proposed amendment and be prepared to vote on it in Athens.

ASB PRE-REGISTRATION FORM

UNIVERSITY OF GEORGIA MEETING
(ASB8704-0801)

(TYPE OR PRINT; ONE FORM FOR EACH REGISTRANT, PLEASE)
(DUPLICATE AS NEEDED)

NAME ____

DEPT. ____________________ SCHOOL ____________________

CITY ______________ STATE ______________ ZIP CODE __________

If you have made housing reservations, please provide below the name of the hotel, motel, or housing address for the meeting directory.

____

____

PLACE A CHECK MARK IN THE APPROPRIATE BLANKS:

PRE-REGISTRATION

Regular $18.00 ______ Student $12.00 ______

(Registration at the meeting will be: Regular $20.00; Student $14.00)

MEALS

ASB SOCIAL HOUR & BANQUET
Regular $18.00 ____
Student $13.00 ____

Buffet & Social Hour at State Botanical Garden of Georgia $16.00 ____

BETA BETA BETA Luncheon $ 6.75 ____

SE Chapter, Ecological Society of America Luncheon $ 8.00 ____

Southern Appalachian Botanical Club/SE Section, Botanical Society of America Breakfast $ 5.20 ____

FIELD TRIPS

Wednesday	No. 1....$ 2.00		Saturday:	No. 8....$10.00
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News of Biology in the Southeast

Jon R. Fortman—*News Editor*
Division of Science and Mathematics
Mississippi University for Women
Columbus, Mississippi 39701

ABOUT PEOPLE AND PLACES

Alabama

University of North Alabama, Department of Biology. *Dr. Steve Timme* (Ph.D. Mississippi State University) has accepted a position with the department as an Assistant Professor. His research interests are on neotropical and southeastern United States hepaticae. He also has the responsibility of developing the herbarium and curating the bryophyte collection.

Tuskegee University, Department of Biology. The Natural Science Research Division of the Carver Research Foundation has adopted the program theme: "Research Competitiveness in Selected Biotechnologies as we Approach the Year 2000." The biotechnologies selected include cell culture, monoclonal antibody production, electron microscopy, and computer simulation models for biomedical research. All of these technologies are undertaken in the Carver Research Foundation Building which contains all the major and auxiliary equipment necessary to carry out ultrastructural research.

Florida

University of South Florida, Department of Biology. *Dr. Daniel Lim,* a microbiologist, recently completed a one-year study verifying a test for early detection of Group B Streptococci bacteria in pregnant women. *Dr. Lim's* test, using his culture medium called the Lim Group B Strep broth, permits rapid detection of the bacteria, identifying high risk mothers within five hours. The study was conducted at the Orlando Regional Medical Center by *Dr. Walter Morales,* Chief Resident of Obstetrics and Gynecology, and *Deno Kazanis,* Director of the Orlando laboratory of the Florida Department of Health and Rehabilitative Services. The test was approved by the FDA a year ago and is now marketed by two research firms. A sweeter grapefruit is the goal of *Dr. Richard Mansell,* who is studying what makes the fruit bitter to taste. Limonin, a substance second-most bitter to quinine, occurs naturally in grapefruit and determines how it tastes. *Dr. Mansell* developed a test to determine the amount of limonin in samples. His test was licensed by USF to a California firm, Idetek Inc., to sell commercially. *Dr. Glen Woolfenden,* in collaboration with *Dr. John Fitzpatrick* of the Field Museum of Natural History in Chicago, recently published through Princeton University Press a book entitled Florida Scrub Jay: Demography of a Cooperative-breeding Bird. *Woolfenden* is Professor of Biology and is a research associate at both the Field Museum and the Archbold Biological Station in Lake Placid, Florida. He also received the Brewster Award from the American Ornithologists Union at their annual meeting in 1985.

Archbold Biological Station, Lake Placid. *Dr. Ronald L. Myers,* a research biologist at the Station since 1982, has accepted a position as Southeastern Regional Fire Ecologist with The Nature Conservancy. The new job will enable him to implement on a regional basis many of the ideas developed through his research at the Station. His headquarters will be at Tall Timbers Research Station near Tallahassee. This relative proximity to ABS will enable him to continue several of his projects which are currently underway here. *Dr. Shirley R. Denton* joined the staff as a postdoctoral fellow in September 1986. Her interests are in the areas of forest ecology, biometrics, and computer science. Her Ph.D. in ecology is from the University of Michigan. Her research at the Station involves computer modelling of environmental influences on vegetation-landscape patterns.

Rollins College, Department of Biology. The W. M. Keck Foundation has awarded $75,000 to the Science Division for the purchase of scientific equipment. A portion of these funds have been used to purchase a UV-vis spectrophotometer, a superspeed refrigerated centrifuge, and a video microprojector system for compound and stereomicroscopes.

Georgia

Valdosta State College, Department of Biology. *Dr. J. Richard Carter* (Ph.D. Vanderbilt University) has been appointed Curator of the Herbarium and Assistant Professor of Biology. *Dr. Carter* is particularly interested in the biosystematics of the Genus *Cyperus,* as well as the flora of the Atlantic-Gulf Costal Plains.

Georgia Southern College, Department of Biology. *Dr. Kishwar Mirza Maur,* Associate Professor of Biology, received a Faculty Development Summer Sabbatical Grant for 1986. These grants are competitively awarded to faculty who submit research proposals. Her research dealt with biological control of mosquitoes using terrestrial and mycotic fungi.

Georgia Southwestern College, Department of Biology. *Dr. James W. Russell* has been named Chairman of the Division of Arts and Sciences. He formerly held the post of Chairman of the Biology Department. *Dr. William L. Tietjen* will take over as Chairman of the Biology Department. *Dr. Bob Herrington* has joined the department on a one year appointment.

Kentucky

Murray State University, Department of Biological Sciences. *Dr. Richard Pratt* has joined the department as an Assistant Professor and Director of the Hancock Biological Station. He was formerly a Research Associate and Assistant to the Director at the University Center for Environmental Studies, VPI & SU. His research expertise is in protozoology and aquatic toxicology. *Dr. Tim Johnston* has also joined the department as an Assistant Professor. *Dr. Johnston* was a postdoctoral fellow in the Department of Biochemistry and Biophysics at Texas A&M University. His areas of expertise are molecular biology and bioluminescence. *Dr. M. D. (Dardy) Hassell* has been awarded a wetlands study grant and has recently completed a 4-year vegetational analysis of the Land-Between-the-Lakes in Western Kentucky. *Dr. Joe King* and one of his graduate students, *Lynn Jarrett,* have completed a Corps of Engineers funded study of the algal flora and water quality of Lake Barkley. *Dr. Tom Timmons,* and his graduate students, *Larry Bull, Russell Johnson, Scott Hale, Tim Hoffnagle,* and *John Soldo,* have been engaged in a two-year study of the commercial fisheries of Kentucky and Barkley Lakes supported by the Kentucky Department of Fish and Wildlife Resources and the Tennessee Wildlife Resource Agency. *Dr. Steve White* received the 1986 Wildlife Publication Award from the Wildlife Society for his research on the ecology, bioenergetics, and agricultural impacts of a winter-roosting population of blackbirds and starlings. *Kevin Flowers,* a graduate student in *Dr. White's* lab, won the best student paper award at both the Southeastern Student Conclave of The Wildlife Society and the Annual Meeting of the Kentucky Chapter of The Wildlife Society on the incidence of lead-poisoning in Canada geese from Ballard County, Kentucky. *Dr. James Sickel* is starting an interdisciplinary project with *Dr. Thomas Kind* in Geosciences examining Kentucky Lake's water quality using LANDSAT remote sensing. *Dr. Harold Eversmeyer* received the 1986 Murray State University Board of Regents Award for Teaching Excellence. This award follows his recent recognition by the Kentucky Academy of Science as the outstanding science teacher in the Commonwealth of Kentucky. *Dr. Wesley Shoop* has taken a one-year leave to conduct research at the Merch, Sharp and Dohme Research Laboratories in New Jersey. *Ms. Kathy Morris* received a grant from the Commonwealth of Kentucky to conduct a new training program for medical assistants.

Louisiana

Louisiana College, Department of Biology. *Dr. Edward H. Wanhoff, Jr.,* a microbiologist/immunologist, has retired after 25 years of distinguished teaching. The position has been filled by *Dr. Preston McKee,* formerly of Mississippi University for Women.

Louisiana State University, Department of Botany. *Dr. Meredith Blackwell,* Associate Professor of Botany, was elected Secretary of the Mycological Society of America (MSA) and participated in a Symposium on "Interfaces—Arthropods and Fungi" at the Annual Meeting. *Dr. Blackwell* has been invited to present a paper in a minisymposium on insects and fungi to be held in the Spring of 1987 in Eugene, Oregon. *Dr. Thomas S. Moore,* Chairman of the Department, was recently appointed interim Chairman of the Department of Microbiology. Although administrative offices will be combined during *Dr. Moore's* dual chairmanship, the two departments will remain separate. *Dr. Moore* participated in a Symposium at the 7th International Plant Lipid Conference in Davis, California, and has been invited to speak at the International Botanical Congress in West Berlin. *Dr. G. Bruce Williamson* was awarded a grant from the American Philosophical Society for the study entitled, "Extreme radial changes in specific gravity of tropical woods."

Mississippi

Mississippi University for Women, Division of Science and Math. *Dr. Ronald Baer* (Ph.D. VPI & SU) is teaching part-time in the department while pursuing a nursing degree. *Dr. Baer* comes from Mississippi State University where he worked as an Assistant Entomologist in the Crop Science Research Laboratory.

North Carolina

University of North Carolina at Wilmington, Department of Biological Sciences. *Dr. Ileana A. Clavijo* has joined the faculty as an Assistant Professor. An ichthyologist with interests and experience in tropical reef fish communities, *Dr. Clavijo* has assumed major responsibility for the Marine Biology course. She replaces *Mr. Jack Dermid* who retired last year.

Duke University, Department of Botany. The annual meeting of the Council of Chairs of Botany/Plant Science Departments and Programs was held on 18 October 1986, in the Department of Botany. Two informal presentations were made by outstanding senior program directors in plant-science research. *Dr. Jerome P. Miksche* if the Agricultural Research Service, U.S. Department of Agriculture discussed opportunities for botanists in the federal government. *Dr. Michael Montague* of the Research and Development Staff of the Monsanto Company talked about opportunities for plant scientists in the private sector. These discussions complemented each other and covered a large portion of the possibilities of nonacademic employment for professional botanists. In addition, problems of general concern to programs in the plant sciences were raised.

Pfeiffer College, Biology Department. *Dr. Steve C. Dial* has been appointed Chairman of the Division of Natural and Health Sciences. *Dr. Dial* has been on the staff of Pfeiffer's Biology Department for 23 years. *Dr. Clyde H. Robertson,* former Natural and Health Sciences Chairman, is taking a year's leave of absence.

North Carolina State University, Department of Botany. *Dr. William F. Thompson,* a plant molecular biologist, formerly with the Carnegie Institute of Washington, Stanford, California, has recently joined the department. He holds a University Research Professorship with emphasis in plant physiology/plant molecular biology and an associate appointment in Genetics. His major research area is the control of gene expression in plant development, especially light regulated genes. *Dr. JoAnn M. Burkholder* has also joined the department as an Aquatic Botanist at the Assistant Professor level. She obtained her Ph.D. under the direction of *Dr. Robert Wetzel* at the Kellogg Biological Station, Michigan State University. Her major area of research is the physiological ecology of algae and vascular plants of aquatic habitats.

Highlands Biological Station, Highlands. The Station will sponsor a Scientific Symposium on Saturday, 27 June 1987, to celebrate it 60th anniversary as a center of biological research in the southern Appalachians. The symposium will focus on topics such as "Field Experiments in Ecology," with feature addresses by *Nelson Hairston* (UNC–Chapel Hill), *Dan Simberloff* (Florida State), and *Henry Wilbur* (Duke), and "Past, Present, and Future of Southern Appalachian Ecosystems," with speakers *Steven Boyce* (Duke), *Paul Delcourt* (Tennessee), *Hazel Delcourt* (Tennessee), *Donald Shure* (Emory), and *Peter White* (UNC–Chapel Hill). An evening banquet will follow, to include an address by a distinguished biologist. Biologists and students are cordially invited to attend. Further information can be obtained by writing the Executive Director, Highlands Biological Station, P.O. Box 580, Highlands, North Carolina 28741.

The Station also supports a broad range of basic research on the biota of the southern Appalachians through its grant-in-aid and scholarship programs. Graduate student and postdoctoral investigators who are conducting field-oriented studies in the southern Appalachians are invited to apply to the Station for support of their research. The amounts of the awards are determined by the time in residency in Highlands. The deadline for receipt of grant applications in 1987 in 1 March. Awards will be announced on 1 April. For further information and application forms, contact the Executive Director. Several one and two-week courses in the summer of 1987 will be offered to advanced undergraduates, graduate students, professionals, and others having serious interests in the environments and biota of the southern Appalachians. Credit is offered through both Western Carolina University and the University of North Carolina at Chapel Hill. Course offerings include: Geomorphology of the Southern Appalachians, 8–13 June. *Steven Yurkovich* and *Gary White* (Western Carolina). Phytoecology of the Southern Blue Ridge, 15–20 June, *Dan Pittillo* (Western Carolina) and *Peter White* (UNC-Chapel Hill). Forestry and Wildlife Concepts for Biologists, 22–27 June, *Steven Boyce* (Duke). Fleshy Fungi of the Southern Appalachians, 20–31 July, *Ronald Petersen* (Tennessee).

Field Biology of Ascomycetes, 3–14 August, *James Kimbrough* (Florida). Prospective students can request course syllabuses and application forms by writing the Executive Director.

South Carolina

Francis Marion College, Department of Biology. *Dr. Larry J. McCumber* has received a three-year $91,614 grant for a research project, entitled "Cellular Defense Mechanisms in the Crayfish." *Dr. William C. Moran*, Vice President for Academic Affairs, said that grants of this nature are normally reserved for research universities, but the unique qualifications of *Dr. McCumber* have attracted ths unusual opportunity for primary research to the college. The results of *Dr. McCumber's* past research with blue crab and crayfish have been published in numerous international journals over the last decade.

Tennessee

The University of Tennessee, Knoxville, Department of Botany. The Spring, 1986 (Vol. 89, No. 1) issue of "The Bryologist" was dedicated to *Dr. A. J. Sharp*. Part of the dedicatory narrative written by the Editor, *Dr. Dominick V. Basile*, states that the issue is dedicated to *Dr. Sharp* in "Appreciation for his long continued contributions to the knowledge and understanding of bryophytes and to the guidance and support of aspiring bryologists and lichenologists." *Dr. A. J. Sharp* has received a Distinguished Service Award from the Tennessee Academy of Science for many years of outstanding service to the Visiting Scientist Program. *Dr. Sharp* received a plaque and a letter from the Director of the Program, *Dr. Bernard W. Benson*.

Virginia

University of Richmond, Department of Biology. *Dr. R. Dean Decker* has been appointed Director of the American Junior Academy of Science. The AJAS is part of the National Association of Academies of Sciences. *Dr. Barbara Mittman* (Ph.D. Univ. of Virginia Medical School, Microbiology) has joined the department to teach genetics. She is continuing her research using techniques of molecular biology and genetics in the study of histones of the yeast *S. cervisiae*.

University of Virginia, Department of Biology. The department is pleased to announce the appointment of *Michael P. Timko* as Assistant Professor in plant biology.

ABOUT MUSEUMS AND BOTANICAL GARDENS

Kentucky

Museum of History and Science, Louisville. The Museum has received a $75,000 grant from the Institute of Museum Services for operating costs and for a major young children's exhibit area, which will open July 1987. The Capital Holding Corporation has pledged $25,000 to the Museum to develop a permanent and a travelling exhibit on computers, robotics, and the science of systems. *Miss Amanda Johnson* has joined the staff as Coordinator of Temporary Exhibits. This is a new position. *Miss Johnson* received her B.A. from Converse College in Applied Art, and is a native of Philadelphia, Mississippi. In addition to her primary responsibilities of construction, collection, design and production of temporary exhibits, she will organize exhibits from the 250,000 plus artifacts in the Museum's collection. A pledge of $125,000 has been made from Kentucky Fried Chicken for the construction of an IMAX theatre. *Dr. Sudduth*, Museum president, said that the KFC officials were very excited about the visual impact IMAX offers, the selection of film topics, and the theatre's abilities to draw people to the city. The screens in the theatre are several stories tall and 76 ft. wide. The theatre will seat 217 patrons. Opening of the theatre is planned for July 1988. KFC's contribution brings the Museum fund drive total to 2.7 million dollars. Another donation was received for $15,000 from the organization's volunteer support group, Friends of the Museum, Inc. A conservation grant for $3016 was received from the Institute for Museum Services. This money will be used to catalogue and survey the Troost mineral collection. The rocks and minerals were purchased in 1874, when the institution was only three years old. At 12,000 specimens, the Troost collection is one of the largest in the museum.

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The ASB BULLETIN

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50th Anniversary

48th Annual Meeting

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The ASB encourages, in the broadest and most liberal sense, the advancement of biology as a science by: the promotion of research, the increase and diffusion of knowledge of biology, emphasis of the relationship of fundamental knowledge of biology to the solution of biological problems, the preservation of biological resources, and by its meetings, reports, discussions, and publications to promote scientific interests and inquiry, thereby adding to the health, happiness, and knowledge of all peoples. The Association meets annually on campuses of universities and colleges located throughout the southeast. Affiliated organizations meeting with the Association are: Southern Appalachian Botanical Club, Southeastern Section of the Botanical Society of America, Southeastern Region of Beta Beta Beta, South Atlantic Chapter of the Society of Wetlands Scientists, Southeastern Chapter of the Ecological Society of America, Southeastern Division of the American Society of Ichthyologists and Herpetologists, Southeastern Fishes Council, and Southeastern Society of Parasitologists. The ASB has representation in Section G Committee of the AAAS. Varying types of membership are available to individuals and institutions. Members receive the Bulletin.

TIME AND PLACE OF FUTURE MEETINGS

1987	April 9–11	University of Georgia, Athens, (50th Anniversary)
1988		Co-Hosts: University of Southern Mississippi and Gulf Coast Research Laboratory, Biloxi, Mississippi

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PROGRAM OF THE 50TH ANNIVERSARY AND 48TH ANNUAL MEETING OF THE ASSOCIATION OF SOUTHEASTERN BIOLOGISTS

UNIVERSITY OF GEORGIA

SOCIETIES MEETING WITH ASB IN ATHENS

American Society of Ichthyologists and Herpetologists, Southeast Region
Beta Beta Beta, Southeastern Region
Botanical Society of America, Southeastern Section
Ecological Society of America, Southeastern Chapter
South Atlantic Chapter of the Society of Wetlands Scientists
Southeastern Society of Parasitologists
Southern Appalachian Botanical Club
Southeastern Fishes Council

GEORGIA CENTER

PHOTOS: *Upper*—INSTITUTE OF ECOLOGY
Lower—STATE BOTANICAL GARDEN OF GEORGIA

GENERAL INFORMATION

Registration—Registration for the 48th annual and 50th anniversary meeting of the Association of Southeastern Biologists, purchase of tickets for the banquet, breakfasts, luncheons, and other special events should have been arranged through pre-registration with the Local Arrangements Committee. Pre-registrants may obtain their information packet and tickets at the Georgia Center registration desk on 8 April from 5:00 P.M. until 10:00 P.M. On Thursday and Friday, 9 and 10 April, from 7:30 A.M. to 5:00 P.M. and 8:00 A.M. to 12:00 noon, respectively, packets and tickets will also be available at the ASB registration booth in the Georgia Center. Late registration is possible at these times. Late registration fees are $14.00 for students and $20.00 for regular members. Please bring your ASB Bulletin (April 1987) to the meeting as free copies will not be available. Extra copies may be purchased at the ASB registration booth for $3.00 each.

Parking and Shuttle Service—ASB participants and guests may park at the Georgia Center for $2.00/day. Other campus parking is not available and violators will be towed away. A shuttle service will run from the Holiday Inn, Howard Johnsons Motor Lodge, Quality Inn, and the Ramada Inn. If you are staying at these hotels either walk or use the shuttle as you probably will not be able to park closer.

Placement Service—Message boards are available in the Georgia Center for those who wish to announce available jobs.

Dining and Lounge Facilities—Meals may be obtained at the Georgia Center. Excellent dining facilities abound in Athens and their location can be found in the registration packet. A map showing restaurant location is also enclosed in your registration packet.

Social Activities for Conference Guests—Check your registration packet for time and place for each scheduled activity.

ASB Banquet—The ASB Banquet and program will be held in the Georgia Center.

Field Trips—All field trips depart from the Georgia Center.

Tickets for Scheduled Meals and Events—Pre-registrants will receive the requested meal and special event tickets with their registration packet. A limited number of tickets for some events will be available for those who did not pre-register.

Breakfasts, Luncheons, and Special Events—A number of breakfasts, luncheons, and special events will occur during the conference. Please check your program for time and place.

Useful Telephone Numbers (Area Code 404-)

Richard Wiegert	542-3370
Frank Golley	542-2968
Georgia Center	542-1311
State Botanical Garden of Georgia	542-6329
Nancy Coile—Field Trips	542-1823

PROGRAM SUMMARY

WEDNESDAY, APRIL 8, 1987

5:00 P.M.-10:00 P.M.	Registration, Georgia Center, First Floor
3:00 P.M.- 5:00 P.M.	Field Trips
5:00 P.M.- 7:00 P.M.	Open House, UGA Institute of Ecology and Departments within UGA's Division of Biological Sciences
7:00 P.M.	ASB Executive Committee Meeting, Georgia Center, First Floor Conference Room
7:00 P.M.-10:00 P.M.	Social Mixer, Institute of Ecology Courtyard
8:00 P.M.	SSP Executive Committee Meeting, Georgia Center, Lower Level Auditorium
7:30 P.M.- 9:00 P.M.	Symposium: "Environmental Education: Update and Teaching of Undergraduates." Main Auditorium. Sponsored by the SE Section, Botanical Society of America. Organized by Dr. Janice Coffey Swab

THURSDAY, APRIL 9, 1987

7:00 A.M.- 8:00 A.M.	Past Presidents' Breakfast, Georgia Center Banquet Area
7:30 A.M.- 5:00 P.M.	Registration, Georgia Center, First Floor
8:00 A.M.- 5:00 P.M.	Exhibits, Georgia Center, First Floor
2:00 P.M.- 4:00 P.M.	Beta Beta Beta Field Trip: Tour through Biological Sciences Facilities

GENERAL PLENARY SESSION, GEORGIA CENTER MAIN AUDITORIUM

8:30 A.M.- 9:45 A.M.	Welcome: Dr. Henry King Stanford, Interim President, University of Georgia Response: Dr. Donald J. Shure, ASB President, Emory University Featured Address: "How to Grow a Tropical Dry Forest," Dr. Daniel H. Janzen, Department of Biology, University of Pennsylvania.

PAPER SESSIONS: GEORGIA CENTER

10:00 A.M.-12:15 P.M.	Symposium: "Host Resistence and Parasite Evasion". Main Auditorium. Sponsored by the Southeastern Society of Parasitologists. Organized by Dr. Ray Damian.
10:00 A.M.-12:15 P.M.	Aquatic Ecology, Session I, Room D
10:00 A.M.-12:00 P.M.	Drought Ecology, Room E
10:00 A.M.-12:15 P.M.	Plant Ecology, Session I, Room L
10:00 A.M.-12:30 P.M.	Plant Systematics, Session I, Room K
10:00 A.M.-12:15 P.M.	Wetlands Ecology, Room G

BUSINESS AND LUNCHEON MEETINGS

12:00 P.M.-12:30 P.M.	Business Meeting, American Society of Ichthyologists and Herpetologists, Southeastern Division. Georgia Center, Room H
12:30 P.M.- 1:00 P.M.	Business Meeting, Southeastern Fishes Council. Georgia Center, Room H
12:15 P.M.- 1:15 P.M.	Luncheon: Southeastern Society of Parasitologists, Georgia Center Banquet Area
12:30 P.M.- 1:30 P.M.	Business-Luncheon Meeting, South Atlantic Chapter of the Society of Wetland Scientists. Georgia Center Banquet Area

PAPER SESSIONS, GEORGIA CENTER

1:30 P.M.- 4:35 P.M.	Symposium: "Terrestrial Communities of the Southeastern United States". Main Auditorium. Sponsored by the SE Chapter of the Ecological Society of America. Organized by Dr. Courtney Hackney.
1:30 P.M.- 4:45 P.M.	Animal Ecology, Room G
1:30 P.M.- 4:15 P.M.	Animal Physiology, Room E
1:30 P.M.- 5:00 P.M.	Ichthyology, Session I, Room D
1:30 P.M.- 4:45 P.M.	Parasitology, Room K
1:15 P.M.- 4:45 P.M.	Plant Ecology, Session II, Room L
1:30 P.M.- 4:00 P.M.	Plant Physiology, Room J
4:00 P.M.- 5:00 P.M.	Forum for Herbarium Curators and Users in the Southeast, Plant Sciences Building, Room 2503.

SPECIAL MEETINGS

3:30 P.M.- 4:00 P.M.	Herbarium Open House for Plant Taxonomists. Plant Sciences Building, Room 2503. Refreshments served.
4:45 P.M.- 5:45 P.M.	Business Meeting, Southeastern Society of Parasitologists, Georgia Center, Lower Level Auditorium
4:45 P.M.- 5:45 P.M.	Business Meeting, SE Chapter Ecological Society of America, Georgia Center, Main Auditorium
6:00 P.M.-10:00 P.M.	Buffet and Entertainment, State Botanical Garden of Georgia (Transportation available)

FRIDAY, APRIL 10, 1987

8:00 A.M.-12:00 P.M.	Late registration, Georgia Center, First Floor
7:00 A.M.- 8:00 A.M.	Breakfast and Business Meeting, Southern Appalachian Botanical Club and SE Section of the Botanical Society of America, Georgia Center Banquet Area
8:00 A.M.- 5:00 P.M.	Exhibits, Georgia Center, First Floor
	Field Trips to Snapfinger Woods (2:30 - 5:00 P.M.) and the Okefenokee Swamp (4:00 P.M. Friday - 10:00 P.M. Saturday).

PAPER SESSIONS, GEORGIA CENTER

8:30 A.M.-11:35 A.M.	Symposium: "Aquatic Communities of the Southeastern United States". Main Auditorium. Sponsored by the SE Chapter of the Ecological Society of America. Organized by Dr. Courtney Hackney.
8:30 A.M.-11:30 A.M.	Cytology/Genetics, Room J
8:30 A.M.-11:45 A.M.	Ichthyology, Session II, Room E
8:30 A.M.-12:00 P.M.	Parasitology/Microbiology, Room K
8:30 A.M.-11:30 A.M.	Plant Ecology, Session III, Room B
8:30 A.M.-11:30 A.M.	Plant Ecology, Session IV, Room D
9:00 A.M.-10:00 A.M.	Teaching, Room G

POSTER SESSION: GEORGIA CENTER, ROOM L

10:00 A.M.- 5:00 P.M.	Posters Available for Viewing
4:00 P.M.- 5:00 P.M.	Presenters with Posters

BUSINESS AND LUNCHEON MEETINGS

11:45 A.M.-12:45 P.M.	ASB Business Meeting Georgia Center, Main Auditorium
12:00 P.M.- 1:30 P.M.	Luncheon, Beta Beta Beta, Georgia Center Banquet Area
12:30 P.M.- 1:30 P.M.	Luncheon, SE Chapter Ecological Society of America, Institute of Ecology

PAPER SESSIONS, GEORGIA CENTER

1:30 P.M.- 5:00 P.M.	Aquatic Ecology, Session II, Room G
3:15 P.M.- 5:00 P.M.	Cellular/Molecular Biology, Room B
1:30 P.M.- 5:00 P.M.	Herpetology, Room D
1:30 P.M.- 3:15 P.M.	Invertebrate Zoology, Room E
1:30 P.M.- 5:00 P.M.	Plant Ecology, Session V, Room K
1:30 P.M.- 5:15 P.M.	Plant Systematics, Session II, Room J
1:30 P.M.- 5:00 P.M.	Symposium: "Fifty Years of Mycology in the Southeast". Main Auditorium. Organized by Dr. Lafayette Frederick.

SPECIAL MEETINGS

6:15 P.M.- 7:30 P.M.	Social Hour, Georgia Center
7:30 P.M.	ASB Banquet, Georgia Center Banquet Area Past President's Address: Dr. Lafayette Frederick Presentation of Awards

SATURDAY, APRIL 11, 1987

8:00 A.M.	Field Trips. Departures from Georgia Center parking lot
8:00 A.M.	ASB Executive Committee Meeting, Georgia Center Banquet Area

THURSDAY MORNING GENERAL SESSION

HOW TO GROW A TROPICAL DRY FOREST NATIONAL PARK

When the Spanish came to Central America five hundred years ago, dry tropical forests extended along the Pacific coast from northern Mexico to Panama. Today, less than 2% remains, and only 0.09% has conservation status. A few patches of this forest still occur on the west coast of Costa Rica, where Dr. Daniel H. Janzen, the Plenary Speaker for the 1987 ASB General Session, has launched an unprecedented attempt to regrow a tropical forest as a case study of self-supporting ecological and cultural restoration.

Dr. Janzen, Professor of Biology at the University of Pennsylvania, has been conducting research on plant-animal relationships in the tropics for over 20 years. Considered by many to be the "Dean of Tropical Biologists," he has written more than 250 papers on the complex ecological interactions and natural history of tropical forests. In 1984 he was awarded the prestigious Crafoord Prize, a Swedish prize designed to fill gaps left by the Nobel, for his studies on co-evolution. One of his best-known educational contributions to tropical biology was designing the popular eight-week field course in Costa Rica for the Organization of Tropical Studies in 1965. His research and teaching in evolutionary biology, natural history, and tropical ecology have led him to be recognized as a leading educator and theorist in tropical biology.

The Guanacaste National Park restoration project, spearheaded by Janzen, will use native people and simple technology, such as fire control and planting seeds of native forest species, to regenerate the forest. His goal is to incorporate the existing Santa Rosa National Park into a much larger 700 square kilometer Guanacaste National Park by purchasing adjacent land and educating the people of the region in its value for preservation. This project is one of the first efforts in restoration of an environment and may be seen as a rare bright spot in the future of tropical forest resources.

Dr. Dan Janzen is an enthusiastic lecturer who is outstandingly qualified to deliver an address of interest to all biologists. This presentation is co-sponsored by ASB and by the Southeastern Section of the Botanical Society of America.

THURSDAY MORNING, APRIL 9

SYMPOSIUM - HOST RESISTANCE AND PARASITE EVASION

Sponsored by the Southeastern Society of Parasitologists

Main Auditorium

Presiding: Dr. Ray Damian, University of Georgia

10:00 1. Damian, Ray. (University of Georgia). Resistance and evasion in Schistosomiasis.

10:40 2. Kuhn, Ray. (Wake Forest University). Immune avoidance in protozoan parasite infections.

11:20 3. Kayes, Stephen. (University of South Alabama). Pulmonary immunity to Toxicara canis: venting the spleen does not explain conventional dogma regarding what this nematode did to the respiratory tree.

12:00 Concluding statements and discussion.

AQUATIC ECOLOGY, SESSION I - Room D

Presiding: Dr. Judith L. Meyer, University of Georgia

10:00 4. Webb, Mark A. and Frank J. Bulow. (Tennessee Technological University). Effectiveness of a fish barrier in separating reservoir and tributary stream populations.

10:15 5. Stephan, C. Dianne and David G. Lindquist. (University of North Carolina, Wilmington). The effect of artificial reef structural parameters on fish community development.

10:30 6. De La Cruz, Armando A. (Mississippi State University). Amino acid content of naturally occurring estuarine detritus.

10:45 7. Richardson, Joseph P. (Savannah State College). Georgia inshore marine algal flora: characteristics and relationships within the Carolinian biogeographic province.

11:00 8. Leff, Laura G., J. Vaun McArthur, and Michael L. Scott. (Savannah River Ecology Laboratory and Oregon State University). Bacterial production in a thermally disturbed swamp.

11:15 9. McArthur, J. Vaun and Laura G. Leff. (Savannah River Ecology Laboratory). Effects of heating on the availability of nutrients to aquatic bacteria.

11:30 10. James, R. Thomas. (University of Georgia). Changes in relationships between microbial and chemical factors in ten acid lakes of Florida.

11:45 11. McFadden, J.F., W.L. Pennington, and E.L. Morgan. (Tennessee Technological University). Application of remote automated trout breathing rate monitoring device for assessing acid deposition events.

12:00 12. Muehlstein, Lisa. (University of Georgia). Observations of a wasting disease in eelgrass, Zostera marina.

DROUGHT ECOLOGY: Contributed Papers and Discussion - Room E

Presiding: Dr. Gayther L. Plummer, University of Georgia

10:00 13. Maier, Chris A. and Robert O. Teskey. (University of Georgia). Variations in net photosynthesis and water relations in mature white pine (*Pinus strobus*, L.) during a severe drought.

10:15 14. Townsend, Erika M., Bert M. Cregg and Robert O. Teskey. (University of Georgia). A comparison of physiological effects of drought on loblolly and shortleaf pine.

10:30 15. Apsley, David K., Lindsay R. Boring and Robert O. Teskey. (University of Georgia). Comparative water relations of *Liriodendron tulipifera* L. and *Robinia pseudoacacia* L. during a severe drought.

10:45 16. Plummer, Gayther. (University of Georgia). 1986-Drought: I. Physical aspects

11:00 17. Plummer, Gayther. (University of Georgia). 1986-Drought: II. Effects and impacts.

11:15 18. Plummer, Gayther. (University of Georgia). 1986-Drought: III. Political and socioeconomic biotics.

11:30 General Discussion - Audience participation welcomed.

PLANT ECOLOGY, SESSION I - Room L

Presiding: Dr. Joe E. Winstead, Western Kentucky University

10:00 19. Myers, Ronald L., Sussan E. Boettcher, and Holly A. Tuck. (The Nature Conservancy, Tall Timbers Research Station and Archbold Biological Station). Sand pine (*Pinus clausa*) seeding response following fire.

10:15 20. Shepherd, John. (Mercer University). Nector thievery and reproduction in the alpine wallflower, *Erysimum nivale*.

10:30 21. Luvall, Jeffrey C. (Earth Resources Laboratory, NASA). Using the tims to estimate evapotranspiration from a white pine forest.

10:45 22. Hupp, Cliff R. and John T. Hack. (U.S. Geological Survey). White oak (*Quercus alba L.*) distribution in relation to bedrock and water availability in northern Virginia and Maryland.

11:00 23. Collins, Beverly and John E. Pinder, III. (Savannah River Ecology Laboratory). Distribution of flowering forbs in a 35 yr old field.

11:15 24. Sorenson, James C. (Radford University). Diversity and abundance of V-A mycorrhizae in successional populations of *Andropogon virginicus*.

11:30 25. Young, Donald R. (Virginia Commonwealth University). Within branch leaf variations for the understory tree, *Asimina triloba*.

11:45 26. Smith, Winston Paul and S. West Hagg. (Tennessee Technological University and Southeastern Louisiana University). Plant communities within commercial timberlands of the upper Florida parishes, Louisiana.

12:00 27. Wade, Gary L. (Northeastern Forest Experiment Station, U.S. Forest Service). Species, soil, and community effects on plant nutrient concentrations.

PLANT SYSTEMATICS, SESSION I - Room K

Presiding: Dr. Cynthia Aulbach-Smith, University of South Carolina

10:00 28. Hardin, James W. and Susan L. Sherman. (North Carolina State University and University of Georgia). Foliar surface features of the American Elms (Ulmus).

11:30 29. Sherman, Susan L. (University of Georgia). Multivariate analyses in the genus Ulmus L. in eastern North America.

10:15 30. Rushing, Ann E. and Roland R. Dute. (Auburn University). Pit membranes with tori in the wood of Osmanthus americanus (L.) Benth. & Hook. ex Gray.

10:30 31. Tobe, John D. and John E. Fairey, III. (Clemson University). The vascular flora of the Chauga River drainage, Sumter National Forest.

10:45 32. Currie, H. and Samuel B. Jones. (University of Georgia). Leaf flavonoids of the native species of Hosta (Liliaceae).

11:00 33. Chung, Myong Gi and Samuel B. Jones. (University of Georgia). Pollen morphology of Hosta (Liliaceae) and related genera.

11:15 34. Smith, Gerald L. and Walter S. Flory. (Wake Forest University). Cytological reexamination of Hymenocallis Salisb.

11:45 35. Broyles, Steven B., Robert Wyatt, William M. Houghton, Mary Jo Godt, Suzanne Kolb, and Roger Laushman. (University of Georgia). The breeding system of Zephyranthes atamasco (L.) Herbert.

12:00 36. Pittman, Albert B.. (Arkansas Natural Heritage Commission). Systematic studies in Scutellaria section Mixtae (Labiatae).

12:15 37. Stalter, Richard and Eric Lamont. (St. John's University and New York Botanical Garden). The vascular flora of Hempstead Plains, Long Island, New York.

WETLANDS ECOLOGY - Room G

Sponsored by the South Atlantic Chapter, Society of Wetlands Scientists

Presiding: Dr. G. Ronnie Best, University of Florida

10:00 38. Marty, Rebecca S. and Michael P. Schafale. (Duke University and North Carolina Natural Heritage Program). Determination of the natural communities of a blackwater river swamp system.

10:15 39. Tupacz, Edward G. and Frank P. Day Jr. (Old Dominion University). Root decay rates in the periodically flooded Great Dismal Swamp.

10:30 40. Megonigal, J. Patrick and Frank P. Day. (Savannah River Ecology Laboratory and Old Dominion University). Cypress root decay in a flooded organic soil: a mesocosm approach.

10:45 41. West, Susan K. and Frank P. Day. (Old Dominion University). Root production in the periodically flooded Great Dismal Swamp.

11:00 42. Day, Frank P., Susan K. West, and Edward G. Tupacz. (Old Dominion University). Ground water dynamics in four communities in the Dismal Swamp.

11:15 43. Davis, Mary M. and G. Ronnie Best. (University of Florida). Success criteria for created wetlands in Florida.

11:30 44. Segal, Debra S., Charlotte Pezeshki and G. Ronnie Best. (University of Florida). Relationship between wetland soils and wetland vegetation in the Osceola National Forest.

11:45 45. Pechmann, Joseph H.K., David E. Scott, J. Whitfield Gibbons and Ruth Estes. (Savannah River Ecology Laboratory). Refuge ponds: An experiment in wetlands mitigation.

12:00 46. Erwin, K.L. (K.L. Erwin Consulting Ecologist, Inc.). Distribution of macroinvertebrates in four small isolated marshes in southwest Florida.

THURSDAY AFTERNOON, APRIL 9

SYMPOSIUM - TERRESTRIAL COMMUNITIES OF THE SOUTHEASTERN UNITED STATES

Sponsored by Southeast Section, Ecological Society of America

Main Auditorium

Presiding: Dr. Courtney Hackney, University of North Carolina, Wilmington

1:30 Hackney, Courtney. (University of North Carolina, Wilmington). Introduction

1:35 47. Delcourt, Paul A., Hazel R. Delcourt, Dan F. Morse and Phyllis A. Morse. (University of Tennessee and Arkansas Archaeological Survey). Vegetation history and prehistoric human impacts in the southeastern United States.

2:05 48. Ash, Andrew N., Steven L. Stephenson, and Dean F. Stauffer. (Gardner-Webb College, Fairmont State College and Virginia Polytechnic Institute and State University). Appalachian oak forests.

2:35 49. Hinkle, C. Ross. (The Bionetics Corporation). The mixed mesophytic forest region.

3:05 50. Burbanck, Madeline P. (Emory University). Vegetation of granite outcrops in southeastern United States.

3:35 51. Doerr, Phillip D. (North Carolina State University). Animal communities of the southern mixed hardwood forests.

4:05 52. Richardson, Curtis J. and J. Whitfield Gibbons. (Duke University and Savannah River Ecology Laboratory). Pocosins, bogs and bays.

ANIMAL ECOLOGY - Room G

Presiding: Dr. Raymond D. Semlitsch, Memphis Stste University

1:30 53. Frazer, Nat B., Judy L. Greene and J. Whitfield Gibbons. (Mercer University and Savannah River Ecology Laboratory). Test of Fabens' growth interval model using data on a long lived species, Trachemys scripta.

1:45 54. Crouse, Deborah T. and Larry B. Crowder. (University of Wisconsin and North Carolina State University). A stage-based population model for loggerhead sea turtles and implications for conservation.

2:00 55. Hepp, Gary R., Donna J. Stangohr, Leslie A. Baker and Robert A. Kennamer. (Savannah River Ecology Laboratory). Variation in the egg and duckling components of Wood Ducks.

2:15 56. Smith, Emlyn B. and Winston P. Smith. (Southeastern Louisiana University and Tennessee Technological Unviersity). Nest site characteristics of the Mississippi sandhill crane (*Grus canadensis pulla*) on the Mississippi Sandhill Crane National Wildlife Refuge.

2:30 57. Fleming, Thomas V. and Ronald D. Gettinger. (University of Alabama, Birmingham). Dynamics of an Alabama old field rodent community.

2:45 58. Harvey, Michael J. (Tennessee Technological Unversity). Population decline of the endangered Indiana bat, *Myotis sodalis*, in Tennessee and Arkansas.

3:00 BREAK

3:15 59. Pearson, Scott M. (University of Georgia). Interspecific dynamics of wintertime mixed-species bird flocks.

3:30 60. Bergstrom, Bradley J. (Valdosta State College). Aggression, parasites, and parapatry in chipmunks.

3:45 61. Colin, Germaine and C.B. Coburn. (Tennessee Technological University). Migration of *Peromyscus leucopus* along interstate right-of-way.

4:00 62. Barry, Ronald E., Jr. and Alan A. Heft. (Frostburg State College). Three's company in a western Maryland woodlot.

4:15 63. Brisbin, I.L. and E.L. Peters. (Savannah River Ecology Laboratory). Field studies of contaminant uptake by organisms in aquatic and terrestrial environments.

4:30 64. Scott, David E. and J.W. Gibbons. (Savannah River Ecology Laboratory). Intraspecific density effects on larval *Ambystoma opacum* body size and survival in large-scale field enclosures.

ANIMAL PHYSIOLOGY - Room E

Presiding: Dr. Justin C. Congdon, Savannah River Ecology Laboratory

1:30 65. Varney, D.R., H.C. Hem-Lee, C.J. Kappes, R.S. Newsome, S.L. Jones, M.R. Siegel and P.M. Zavos. (Eastern Kentucky University). Physiological effects of tall fescue toxicity on rat visceral organs and glands.

1:45 66. Varney, D.R., C.J. Kappes, S.L. Jones, R.S. Newsome, M.R. Siegel and P.M. Zavos. (Eastern Kentucky University). The effect of feeding tall fescue seed infected by *Acremonium coenoplialum* on pregnancy and parturition in female rats.

2:00 67. Fischer, Robert U., Justin D. Congdon, Frank J. Mazzoti and Robert E. Gatten, Jr. (Savannah River Ecology Laboratory, Pennsylvania State University and North Carolina State University, Greensboro). Developmental energetics of American alligators.

2:15 68. Congdon, Justin D. and Robert E. Gatten, Jr. (Savannah River Ecology Laboratory and North Carolina State University, Greensboro). Use of anaerobic metabolism to support nesting of painted turtles.

2:30 69. Claiborne, James B. and David H. Evans. (Georgia Southern College and University of Florida). Acid-base effects and ammonia transfers during exposure to high ambient ammonia in a marine fish.

2:45 BREAK

3:00 70. Zavos, Panayiotis M. (University of Kentucky). Comparative measurements of equine spermatozoa concentration between the hemacytometer, spectrophotometer and the Makler chamber method.

3:15 71. Zavos, Panayiotis M., Burhanuddin Salim and Bradley Neil. (University of Kentucky). Libido scores and daily sperm production potential (DSP) in bulls fed different energy level rations.

3:30 72. Turner, Lisa D., J.F. McFadden and E.L. Morgan. (Tennessee Technological University). Correlating oxygen consumption and breathing rates of bluegill (Lepomis macrochirus) using a computer monitored fish respiration chamber.

3:45 73. Morton, David and Dwayne Shuhart. (Frostburg State College). Determination and estimation of total body iron in Peromyscus.

4:00 74. Hogan, G.R. (East Texas State University). Temporal and spatial leucocyte patterns following cadmium treatment.

ICHTHYOLOGY, SESSION I - Room D

Presiding: Dr. David C. Heins, Tulane University

1:30 75. Ross, Steve W., Fred C. Rohde, and David G. Linquist. (North Carolina State University, North Carolina Division of Marine Fisheries, and University of North Carolina). An evaluation of the endangered, threatened, and vulnerable marine fishes of North Carolina.

1:45 76. Linquist, David G. and Patricia Bernier McNeese. (University of North Carolina, Wilmington). Status and biology of the North Carolina population of the freckled blenny, Hypsoblennius ionthas.

2:00 77. Rohde, Fred C. and Steve W. Ross. (North Carolina Division of Marine Fisheries and North Carolina State University). The gobioid fishes of North Carolina.

2:15 78. Powell, Amy and Gary K. Meffe. (Savannah River Ecology Laboratory). Life history patterns of mosquitofish (Gambusia affinis) in thermal and ambient environments.

2:30 79. Doherty, Teresa A. (University of Southern Mississippi). Changes in the feeding behavior of the blacktail shiner, Notropis venustus, in relation to the threat of predation.

2:45 80. Peterson, Mark S., Stephen T. Ross and Daniel E. Gustafson. (University of Southern Mississippi). Morphometric and meristic characteristics of a peripheral population of Enneacanthus.

3:00 81. Etnier, David A. (University of Tennessee). Characters and distribution of Etheostoma duryi and the undescribed golden darter.

3:15 BREAK

3:30 82. Shute, John R. and Peggy W. Shute. (University of Tennessee). Laboratory rearing of endangered and threatened madtoms, Noturus baileyi and N. flavipinnis.

3:45 83. Aho, J.M., Robert U. Fischer, Justin D. Congdon and Christine DeFonzio. (Savannah River Ecology Laboratory). Lipid and reproductive cycles in bluegill, Lepomis macrochirus, in nuclear reactor cooling reservoirs.

4:00 84. Suttkus, Royal D. and Gerald E. Gunning. (Tulane University). Fishes of the lower Mississippi River.

4:15 85. Facey, Douglas E., Gary D. Grossman, and Gene S. Helfman. (University of Georgia). Is the cost of holding position important in microhabitat selection by stream fishes?

4:30 86. Haines, A.G., and V. Brack, Jr. (Wapora, Inc.). Fish species richness in relation to stream order in coastal plain streams of Delaware.

4:45 87. Maurakis, E.G. and J.B. Kahnke. (George Washington University and George Mason University). Construction of spawning nests by two recently described chub species from southeastern United States (Pisces: Cyprinidae).

PARASITOLOGY - Room K

Presiding: Richard Sowadsky, University of North Carolina, David S. Lindsay, Auburn University, and Daniel J. Murphin and Adelfa E. Serrano, University of Georgia

1:30 88. Seed, J.R., J.B. Sechelski, and M.R. Loomis. (University of North Carolina and North Carolina Zoological Park). Resistance to African trypanosomes: innate serum factors.

1:45 89. Sowadsky, Richard A. (University of North Carolina, Chapel Hill). Effects of changing environmental parameters on growth rates of different clones of Trypanosoma brucei gambiense.

2:00 90. Osborn, J.M., J.E. Hall and R.E. Miller. (University of North Carolina and Walter Reed Army Institute of Research). Comparison of metabolic profiles of mice infected with Trypanosoma brucei rhodesiense and Schistosoma mansoni.

2:15 91. Lushbaugh, W.B., Paal C. Klykken and G.A. Gentry. (University of Mississippi). Effect of Trichomonas vaginalis secretions on BHK-21 cells.

2:30 92. Jarecki-Black, J.C., E.R. James and A.B. Glassman. (Medical University of South Carolina). Protection against Leishmania donovani using a parasite microsomal fraction.

2:45 93. Sundermann, C.A., David S. Lindsay, Byron L. Blagburn. (Auburn University). Interaction of lectins with avian Cryptosporidium.

3:00 BREAK

3:15 94. Kirschner, K.F. and B.J. Bogitsh. (Vanderbilt University). Immunoinhibitory effects of rabbit anti-bovine cathepsin D on schistosomes.

3:30 95. Vandergon, T.L., J.H. Burden, G.P. Noblet, and J.M. Colacino. (Clemson University). Identification and characterization of hemoglobin of a gymnophallid metacercaria, a parasite of the marine polychaete Amphitrite ornata.

3:45 96. Burden, James H. and Gayle P. Noblet. (Clemson University). Occurrence of metacercariae (Trematoda: Gymnophallidae) in metanephridia of Amphitrite ornata (Annelida: Terebellidae).

4:00 97. Mobley, Ronald W. and Grover C. Miller. (North Carolina State University). The bird schistosome, Gigantobilharzia huronensis, in the laboratory mouse.

4:15 98. Jetton, Thomas L. and Burton J. Bogitsh. (Vanderbilt University). Morphological, cytochemical, and biochemical observations on spermatogenesis and mature sperm in trematodes, with emphasis on schistosomes.

4:30 99. Thoney, Dennis A. (College of William and Mary). Morphology of the Oncomiracidium of Heteraxinoides xanthophilis (Monogenea), a gill parasite of spot, Leiostomus xanthurus (Sciaenidae).

PLANT ECOLOGY, SESSION II - Room L

Presiding: Dr. Beverly S. Collins, Savannah River Ecology Laboratory

1:15 100. Spira, Timothy P. (Georgia Southern College and White Mountain Research Station). Ecological and distributional characteristics of alpine annual plant species in the White Mountains of California and Nevada.

1:30 101. Loehle, Craig. (Savannah River Ecology Laboratory). Defensive investments in trees: a critical life history parameter.

1:45 102. Kokesh, Amy C. and David L. Edens. (Marshall University and West Virginia State College). The bog forest community at Cranberry Glades, West Virginia: I. Arboreal stratum.

2:00 103. Muller, Robert N., Paul J. Kalisz and Thomas W. Kimmerer. (University of Kentucky). Intraspecific variation in production of astringent phenolics over a vegetation-resource availability gradient.

2:15 104. Swab, Janice Coffey. (St. Mary's College). Vegetation of inner Mongolia (China).

2:30 105. Box, Elgene O. (University of Georgia). Comparing the natural vegetation of East Asia and eastern North America.

2:45 106. Fujiwara, Kazue. (Yokohoma National University). Mangrove forests of East and Southeast Asia, with comparison to eastern North America.

3:00 BREAK

3:15 107. Sharma, G.K. (University of Tennessee, Martin). Altitudinal variation in the cuticular patterns of Cannabis sativa L. (marihuana).

3:30 108. Kuo, Yau-Lun and Robert O. Teskey. (University of Georgia). Effects of site preparation treatments on competing vegetation, resource availability, and physiological and growth responses of loblolly pine seedlings.

3:45 109. Imm, Donald W. and Carl D. Monk. (University of Georgia). Seasonal patterns of leaf weight, surface area and nutrient content of evergreen and deciduous subcanopy plants on a Southern Appalachian hardwood forest.

4:00 110. Murdy, W.H., M.E.B. Carter and N. Wolff. (Emory University). Regulation of the timing of pollen germination by the pistil in Talinum mengesii.

4:15 111. Nelson, John B. (South Carolina Nongame and Heritage Trust Program). Vegetation on the Iredell soil of the Piedmont of South Carolina.

4:30 112. Payne, J. Lewis, Donald R. Young and John F. Pagles. (Virginia Commonwealth University). Habitat analysis of the endangered populations of the northern flying squirrel in the southern Appalachians.

PLANT PHYSIOLOGY - Room J

Presiding: Dr. Kenneth W. McLeod, Savannah River Ecology Laboratory

1:30 113. Ballal, S.K. (Tennessee Technological University). The in vitro culture of excised ovules of cotton.

1:45 114. All, T.M. and S.K. Ballal. (Tennessee Technological University). In vitro organogenesis of a recalcitrant xerophyte.

2:00 115. Stone, B.P. and Lisa A. Stokes. (Austin Peay State University). Effects of Ca2+ inhibitors on GA enhanced hypocotyl elongation.

2:15 116. Samuelson, Lisa J. and Robert O. Teskey. (Universtiy of Georgia). Photorespiration in loblolly pine.

2:30 117. Stumpff, Nancy J., Lisa A. Donovan and Kenneth W. McLeod. (Savannah River Ecology Laboratory). High temperature flooding injury of bald cypress and water tupelo seedlings.

2:45 BREAK

3:00 118. Watson, Mark B., Alan R. White, Cheryl E. Williams, James P. Gill and H. Wayne Elmore. (Marshall University). Bracken fern polysaccharides.

3:15 119. McLeod, Kenneth W. and Laural J. Glazer. (Savannah River Ecology Laboratory). Comparative photosynthesis of woody seedlings grown under differing light conditions.

3:30 120. Reynolds, John D., Gerald C. Llewellyn, C.E. O'Rear, W.V. Dashek. (Virginia Commonwealth University, Bureau of Toxic Substances Information, George Washington University and Atlanta University). Mycotoxin effects on wheat seedlings: Elongations and 65ZnCl2 uptake and distribution.

3:45 121. Davidson, Mary L. and Armando A. De La Cruz. (Mississippi State University). Toxicants from leaves of the mangrove plant Aegiceras corniculatum.

FORUM FOR HERBARIUM CURATORS AND USERS IN THE SOUTHEAST
Plant Sciences Building, Room 2503

4:00 122. Massey, Jim, Nancy Coile, Jim Matthews and Cindy Aulbach-Smith. (University of North Carolina, University of Georgia, University of North Carolina, Charlotte, and University of South Carolina). Forum for herbarium curators and users: space and fumigation problems in southeastern herbaria.

FRIDAY MORNING, APRIL 10

SYMPOSIUM - AQUATIC COMMUNITIES OF THE SOUTHEASTERN UNITED STATES

Sponsored by Southeast Section, Ecological Society of America

Main Auditorium

Presiding: Dr. Leonard A. Smock, Virginia Commonwealth University

8:30 Hackney, Courtney. (University of North Carolina, Wilmington). Introduction
8:35 123. Monrad, John R. (Eastern Kentucky University). Tectonics, eustatics, and the evolution of drainage systems in the southeastern United States.
9:05 124. Fitzpatrick, J.F., Jr. (University of South Alabama). Evolution of southeastern drainage systems: zoogeographic considerations.
9:35 125. Mulholland, Patrick J. and David R. Lenat. (Oak Ridge National Laboratory and North Carolina Division Environmental Management). Biotic communities of streams of the southeastern piedmont, Atlantic drainage.
10:05 126. Beckett, David C. (University of Southern Mississippi). An ecological comparison of the Ohio and lower Mississippi rivers.
10:35 127. Kimmel, Bruce L., David M. Soballe, Robert H. Kennedy and Robert Gaugush. (Oak Ridge National Laboratory and USAE Waterways Experiment Station). Biotic communities of the Southeast: reservoirs and river-reservoir systems.
11:05 128. Moore, Richard H. (University of South Carolina). Biotic communities of the southeastern United States: freshwater backbays and lagoons.

CYTOLOGY/GENETICS - Room J

Presiding: Dr. Michael C. Wooten, Auburn University

8:30 129. King, Patricia S. (Univeristy of Georgia). Comparative population genetic structure of two species of beetles on outcrops in the Southeast.
8:45 130. Beatty-DeSana, Jeanne W.(Georgia Retardation Center (DHR)) Human chromosome response to genetic-environmental interaction.
9:00 131. Leberg, Paul L., Peter W. Stangel, Julia I. Smith and James Earl Kennamer. (Savannah River Ecology Laboratory, University of California, Berkeley, and National Wild Turkey Federation). Influence of restocking on the genetic variability of wild turkeys.
9:15 132. Stangel, Peter W. and Michael H. Smith. (Savannah River Ecology Laboratory). Refuge design and the dynamic genetic nature of natural populations.
9:30 133. Scribner, Kim T. (Savannah River Ecology Laboratory). Environmental components of spatial differentiation in genetic and life history traits in Hawaiian populations of mosquitofish.
9:45 134. Angus, Robert A. (University of Alabama, Birmingham). Genetic and biochemical studies of pigment variants in Poeciliid fishes.
10:00 BREAK

10:15 135. McDonald, Mara A. (Savannah River Ecology Laboratory and University of Florida). Age-dimorphism in plumage and increased levels of genetic heterozygosity in juveniles of hispaniolan Palm Tanagers.

10:30 136. Howard, James and Fred Allendorf. (Frostburg State College and University of Montana). Heterozygosity and developmental stability in cutthroat trout.

10:45 137. Mulvey, Margaret, John M. Aho, Michael H. Smith and Charles Lydeard. (Savannah River Ecology Laboratory). Spatial differentiation in a host-parasite system: genetic variation in the liver fluke, *Fascioloides magna*, and white-tailed deer.

11:00 138. Korgi, Albert and John W. Harris. (Tennessee Technological University). Biochemical taxonomy and genetic variability in the crayfish genus *Orconectes*.

11:15 139. Keeler, Clyde E. (Georgia College). The albino syndrome.

ICHTHYOLOGY, SESSION II - Room E

Presiding: Dr. Franklin F. Snelson, Jr., University of Central Florida

8:30 140. Moser, Mary L. (North Carolina State University). Feeding activity of juvenile spot, *Leiostomus xanthurus*, after rapid salinity changes.

8:45 141. Birkhead, William S. (Columbus College). Population structure of the bandfin shiner, *Notropis zonistius*, in two small piedmont streams in westcentral Georgia.

9:00 142. Crumby, W. Dennis and Frank J. Bulow. (Tennessee Technological University). Growth dynamics of an introduced population of redeye bass in a north-central Tennessee stream.

9:15 143. Quisenberry, Scott S. and Frank J. Bulow. (Tennessee Technological University). Comparison of scale and otolith techniques for determination of age and growth in rock bass (*Ambloplites rupestris*).

9:30 144. Hales, L.S. Jr. and G.S. Helfman. (University of Georgia). Growth and mortality of spot (*Leistomus xanthurus*) in the Stono River estuary, South Carolina.

9:45 145. Ramey, Barbara A. and Lee A. Colten. (Eastern Kentucky University). Avoidance responses of juvenile fathead minnows to acid pH.

10:00 BREAK

10:15 146. Heins, David C. (Tulane University). Proximal variation in the reproduction of the longnose shiner, *Notropis longirostris*.

10:30 147. Winner, Brent L. (University of North Carolina, Wilmington). Categorization and length-depth comparisons of deepwater sharks.

10:45 148. Kanehl, Paul D. (Tennessee Technological University). The rainbow trout fishery of the Center Hill Dam tailwater.

11:00 149. Maurakis, E.G., R.G. Otto and E.S. Perry. (Potomic Electric Power Co., R.G. Otto and Associates and University of Maryland). Factors affecting the electrofishing efficiency for redbreast sunfish (*Lepomis auritus*).

11:15 150. Orrell, Thomas M. and William S. Woolcott. (University of Richmond). A phenetic analysis using the skeletal characters of nine species of darters: *Percina* (*Alvordius*).

11:30 151. King, Mark A., Robert G. Graham, and William S. Woolcott. (Virginia Commonwealth University, Virginia Power Company and University of Richmond). A comparison of growth of Micropterus dolomieui (smallmouth bass) from the North Anna and the South Anna rivers, Virginia.

PARASITOLOGY/MICROBIOLOGY - Room K

Presiding: Charles T. Faulkner and Michael H. Orloff, University of Tennessee

8:30 152. Orvos, David R., George H. Lacy, and John Cairns, Jr. (Virginia Polytechnic Institute and State University). Use of soil microcosms in evaluating survivability of a genetically engineered microorganism.

8:45 153. Luciano, Juan Z. and Cathy Hix. (Tennessee Technological University). The effects of ultraviolet radiation on Saccharomyces uvarum metabolism.

9:00 154. Babbitt, Michael J., David E. Crowley, and C.P.P. Reid. (University of Florida). Biodegradation of ferrioxamine B, a hydroxamate siderophore.

9:15 155. Edwards, Robert W., Constance A. Bell and Timothy Weiner. (University of North Carolina). Parasitic infections of migrant farmworkers in eastern North Carolina.

9:30 156. Faulkner, Charles T. and Sharon Patton. (University of Tennessee). Analysis of paleofecal samples from Pig Bone Cave, Van Buren County, Tennessee.

9:45 157. Hendrix, Charles M. (Auburn University). Aberrant cerebellar myiasis due to a larval Cuterebra sp. in a kitten: a case report.

10:00 BREAK

10:15 158. Johnson, Sandra Strawbridge, Charles T. Faulkner, Sharon Patton and Michael A. Breider. (University of Tennessee). Oral efficacy evalulation of SCH 32481/G-418 (Hapadex-Schering Corporation) against the naturally occurring gastrointestinal parasites of dogs in Knoxville, Tennessee.

10:30 159. Orloff, Michael H., Charles T. Faulkner, Sharon Patton, Sandra Strawbridge Johnson and Nancy Johnson. (University of Tennessee). Evidence of an anthelmintic resistant population of trichostrongyles in a dairy goat herd in northern Georgia.

10:45 160. Bone, Leon W. and Kurt P Bottjer. (Animal Parasite Research Laboratory, USDA). Morphological effects of Bacillus thuringiensis israelensis on eggs and larvae of Trichostrongylus colubriformis.

11:00 161. Blagburn, Byron L., John C. Frandsen and David S. Lindsay. (Auburn University and Animal Parasite Research Laboratory, USDA). Amprolium for control of coccidiosis in pastured pygmy goats: comparison of two regimens.

11:15 162. Patton, Sharon, Sandra Strawbridge Johnson, John New and Marijane Davis. (University of Tennessee). Serological survey for toxoplasma antibodies in white-tailed deer of Cades Cove, Great Smokey Mountains National Park.

11:30 163. Schorr, Mark S. (Mississippi State University). Enteric protozoans of amphibian larvae.

11:45 164. Lindsay, David S., Byron L. Blagburn and Christine A. Sundermann. (Auburn University). Development of Cryptosporidium baileyi in avian embryos.

PLANT ECOLOGY, SESSION III - Room B

Presiding: Dr. Robert N. Muller, University of Kentucky

8:30 165. Lau, Robyne R. and Donald R. Young. (Virginia Commonwealth University). The effect of integration on the water relations and survivorship of a clonal understory herb.

8:45 166. Broyles, Steven B. and Robert Wyatt. (University of Georgia). Floral displays and reproduction in Poke Milkweed (*Asclepias exaltata* L.)

9:00 167. Harker, Anne C., Cory W. Berish and Harvey L. Ragsdale. (Emory University). Root dynamics in relation to ecosystem nitrogen and root litter quality in early successional forests of the southern Appalachians.

9:15 168. Humphrey, L. David. (Georgia Department of Natural Resources). Population trends of *Baptisia arachnifera* in pine plantations

9:30 169. Ward, Deanna M. and W. Dean Cocking. (James Madison University). DECORANA ordination of herb and shrub layers in mesic forest stands along Skyline Drive in Shenandoah National Park, VA.

9:45 170. Fairey, John E. III, K.M. Peterson and Lloyd G. Webb. (Clemson University and L.G. Webb Associates). Vegetational changes associated with land application of industrial wastewater near Martin, S.C.

10:00 BREAK

10:15 171. Kelly, Robert C. and R.R. Sharitz. (Savannah River Ecology Laboratory). Settlement-era composition of floodplain and upland forests determined using colonial land surveys.

10:30 172. Knox, Robert G. and Robert K. Peet. (University of North Carolina). Comparing vegetation data sets with bootstrapped ordination.

10:45 173. Byrne, Stephen V. and Thomas R. Wentworth. (North Carolina State University). Relationship between volume and biomass of early successional vegetation and the prediction of loblolly pine seedling growth.

11:00 174. McLeod, Don E. (Mars Hill College). Vegetation patterns and environmental factors in the Black and Craggy Mountains, N.C.

11:15 175. Hawkins, Mike, Lynne Burton, Dana Grantham, William Martin and C.B. Coburn. (Tennessee Technological University and Eastern Kentucky University). Survey of woody flora on the north-facing slope in Savage Gulf Natural Area. Number 1.

PLANT ECOLOGY, SESSION IV - Room D

Presiding: Dr. Edward E.C. Clebsch, University of Tennessee

8:30 176. McCormick, J. Frank. (University of Tennessee). Ecological implications of the Chernobyl accident.

8:45 177. Parton, Elaine E. (Louisiana State University Coastal Ecology Institute). Effects of herbivory on vegetation on delta islands in Atchafalaya Bay, Louisiana.

9:00 178. Visser, Jenneke M. (Louisiana State University). Productivity of two Sagittaria species in a developing delta, Atchafalaya Bay, Louisiana.

9:15 179. Wagner, Lisa K. (Georgia Southern College). Reproductive effort in Poa annua.

9:30 180. Hull, James C. (Towson State University). Comparative nitrogen economy of four California annual grasses.

9:45 181. Schmalzer, Paul A., Mark J. Provancha and C. Ross Hinkle. (The Bionetics Corporation and the National Aeronautics and Space Administration). Vegetation mapping of John F. Kennedy Space Center, Merritt Island, Florida.

10:00 BREAK

10:15 182. Thomas, Ronald L. and W. Dean Cocking. (James Madison University). Increased mercury bioaccumulation in plants growing on experimentally acidified soil.

10:30 183. Baskin, Jerry M., Carol C. Baskin and J. Frank McCormick. (University of Kentucky and University of Tennessee). Seasonal changes in the germination responses of buried seeds of the granite outcrop summer annual endemic Portulaca smallii.

10:45 184. Potter, Christopher S. and Harvey L. Ragsdale. (Emory University). Changes in foliar nutrient resorption during southern Appalachian forest regeneration conflict with Odum's ecosystem theory of successional nutrient cycling dynamics.

11:00 185. Leitman, Helen M. (U.S. Geological Survey, Water Resources Division). Relation of tree communities to the duration of inundation on the Apalachicola River flood plain, Florida.

11:15 186. Van Horn, Gene S. and Larry G. Williams.(University of Tennessee, Chattanooga). A floristic survey of Chilhowee and Bean Mountains in Polk County, Tennessee.

TEACHING - Room G

Presiding: Dr. Janice Coffey Swab, Saint Mary's College

9:00 187. Atkinson, Robert B. (Christchurch School). Establishment of a marine science program at the secondary level.

9:15 188. Haldeman, Janice H. (Erskine College). A model system for demonstrating in vitro plant propagation: cauliflower.

9:30 189. Perry, James W. and David Morton. (Frostburg State College). So you want to write a book?

9:30 190. Swab, Janice Coffey. (Saint Mary's College). Botanical education in Chinese universities.

FRIDAY AFTERNOON, APRIL 10

AQUATIC ECOLOGY, SESSION II - Room G

Presiding: Dr. Armando A. de la Cruz, Mississippi State University

1:30 191. Winstead, Joe E. and Alan W. Reed. (Western Kentucky University and Lindsey Wilson College). Aluminum toxicity on the isopod Caecidotea forbesi (Williams) in relation to leaf litter of Carpinus caroliniana Walt and acidic environments.

1:45 192. Harmon, Jeff L. and James E. Joy. (Marshall University). Distribution, density, and biomass studies on the freshwater mussel, Anodonta imbecillis (Unionidae), from the McClintic Wildlife Station, Mason County, West Virginia.

2:00 193. Lasalle, Mark W. and T. Dale Bishop. (University of Georgia). Gut content analysis of larval Diptera (Dolichopodidae) from a Mississippi brackish water marsh.

2:15 194. Schmidt, Denise A. and Donald C. Tarter. (Marshall University). Ecological life history of the stonefly Acroneuria carolinensis (Banks) in a West Virginia stream.

2:30 195. Meadows, James A. and Donald C. Tarter. (Marshall University). Benthic macroinvertebrate community structure and physicochemical conditions in the Cranberry River, Nicholas County, West Virginia.

2:45 196. Richardson, Joseph P. (Savannah State College). Effects of sedimentation, grazing and predation on development of a subtidal jetty community.

3:00 197. Nelson, Charles H. (University of Tennessee, Chattanooga). Emergence patterns and stonefly diversity in a Great Smoky Mountain river drainage system in Tennessee.

3:15 BREAK

3:30 198. Barrociere, Leo J. and C.B. Coburn. (Tennessee Technological University). The ecological assessment and distribution status of the Nashville crayfish, Orconectes shoupi.

3:45 199. O'Bara, C.J. (Tennessee Technological University). Utilizing fish community structure to evaluate lotic integrity.

4:00 200. Falbo, Mary Beth and Thomas E. Weaks. (Marshall University). The physical and chemical effects of water hyacynth on toxic acid mine water.

4:15 201. Hoylman, A.M., A. Atakkaan, M.D. Adkins, M.C. Waldron and A.R. White. (Marshall University). Mutagenicity of organic extracts of Kanawha River sediments.

4:30 202. Stokes, Glenn D. and William S. Birkhead. (Columbus College). pH discrimination of two Cyprinid fish.

4:45 203. Shaffer, Gary P. (Louisiana State University). K-systems analysis: a powerful new technique for analyzing ecological data.

CELLULAR/MOLECULAR BIOLOGY - Room B

Presiding: Dr. Gerhard Kalmus, East Carolina University

3:15 204. Dendinger, James E. (James Madison University). Digestive proteases in the midgut gland of the Atlantic blue crab, *Callinectes sapidus*.

3:30 205. Henderson, Ingrid L., Cletus M. Sellers, Jr., Norman E. Garrison, and David R. Orvos. (James Madison University). Effects of chlorination upon ability of the cytosolic components to support in vitro translation by rainbow trout (*Salmo gairdneri*) hepatic ribosomes.

3:45 206. Farrar, William W. (Eastern Kentucky University). Purification and properties of pig liver and muscle enolases.

4:00 207. Kiffmeyer, William R. and William Farrar. (Eastern Kentucky University). Purification and properties of pig heart pyruvate kinase.

4:15 208. Farrar, William W. and Young Jo K. Farrar. (Eastern Kentucky University). Steady-state kinetic mechanisms of house sparrow heart and flight muscle lactate dehydrogenases.

4:30 209. Poulos, John E. and Gerhard Kalmus. (East Carolina University). The effects of indomethacin and dexamethasone on fibroblast chemotaxis.

4:45 210. Silver, Stanley L. and Valgene L. Dunham. (Western Kentucky University). The in vitro translation of glutamine synthetase.

HERPETOLOGY - Room D

Presiding: Dr. C. Kenneth Dodd, U.S. Fish and Wildlife Service

1:30 211. Murphy, Kimberly R. and George G. Murphy. (Middle Tennessee State University). Toxicity of ovarian eggs of *Bufo americanus* to *Mus musculus*.

1:45 212. Meffe, Gary K. and Andrew L. Sheldon. (Savannah River Ecology Laboratory and University of Montana). Habitat selection by dwarf waterdogs (*Necturus punctatus*) in South Carolina streams, with life history notes.

2:00 213. Arndt, Rudolf G. and A. Brett Bragin. (Stockton State College) Status and ecology of *Ambystoma t. tigrinum* in Delaware.

2:15 214. Ireland, Patrick H. (Radford University). Effects of chronic sub-lethal exposure of salamanders to acid rain.

2:30 215. Hinton, Thomas G., F. Ward Whicker and John E. Pinder, III. (Savannah River Ecology Laboratory and Colorado State University). The kinetics of Ca, Sr and Ra in the pond slider (*Trachemys scripta*) as influenced by dietary calcium.

2:45 216. Dodd, C. Kenneth, Jr., Kevin M. Enge and James N. Stuart. (U.S. Fish and Wildlife Service). Reptiles on highways in north central Alabama: species, mortality, and environmental influences.

3:00 217. Dodd, C. Kenneth, Jr. (U.S. Fish and Wildlife Service). The effects of disease on the flattened musk turtle, *Sternotherus depressus*.

3:15 BREAK

3:30 218. Forester, Don C., David V. Lykens and W.K. Harrison. (Towson State University). Sexual selection in the spring peeper: is female choice dependent on male calling persistence?

3:45 219. Fugler, Charles M. and Grover C. Miller. (University of North Carolina, Wilmington and North Carolina State University). A dry-season herpetological community in Amazonian Bolivia.

4:00 220. Lovich, Jeff. (Savannah River Ecology Laboratory). Geographic variation in the seasonal activity of spotted turtles, Clemmys guttata.

4:15 221. Wallin, Julie and J. Whitfield Gibbons. (Savannah River Ecology Laboratory). Growth of juvenile slider turtles (Trachemys scripta) as a consequence of sex, year and habitat.

4:30 222. Eckert, Karen L. (University of Georgia). Tag loss and the estimation of sea turtle abundance.

4:45 223. Eckert, Scott A. (University of Georgia). Diving patterns with a new deep diving record for the leatherback sea turtle, Dermochelys coriacea, during internesting intervals.

INVERTEBRATE ZOOLOGY - Room E

Presiding: Dr. Carmine A. Lanciani, University of Florida

1:30 224. Nelson, Diane R. and George Musil. (East Tennessee State University). Electron microscopic observations of the tardigrade Macrobiotus tonollii.

1:45 225. Nelson, Diane R., Rudolph Prins, and Robert O. Schuster. (East Tennessee State University, Western Kentucky University and University of California, Davis). Preliminary report on Tardigrada from Southern Chile.

2:00 226. Brown, K.M. and T.D. Richardson. (Louisiana State University). The effect of predator size and density on the foraging ecology of Thais haemastoma.

2:15 227. Richardson, Terry D. and Joseph F. Scheiring. (Louisiana State University and University of Alabama). Life histories of Elimia clara and E. cahawbensis (Gastropoda: Pleuroceridae).

2:30 228. Smith, Craig M. and Courtney T. Hackney. (University of North Carolina, Wilmington). Effects of hydrocarbon covered substrate on intertidal recruitment of Crassotrea virginica.

2:45 229. Joy, James E. and Jeff W. Hively. (Marshall University). Unionicola sp. (Acarina: Hydracarina) infection in Anondonta imbecillis (Say), at the McClintic Wildlife Station, Mason Co., West Virginia.

3:00 230. Eckert, K.L. and S.A. Eckert. (University of Georgia). Growth rate and reproductive condition of the barnacle, Conchoderma virgatum, on gravid leatherback sea turtles in Caribbean waters.

PLANT ECOLOGY, SESSION V - Room K

Presiding: Dr. William Martin, Eastern Kentucky University

1:30 231. Crooks, Fred B. (Southern Illinois University). Determining the presettlement forest stand composition and basal area using the original land survey records for the Shawnee Hills physiographic region of Illinois.

1:45 232. Efird, Robert B. and K.M. Peterson. (Clemson University). Corm dynamics and clonal propagation in Tipularia discolor.

2:00 233. Busing, Richard T. (University of Tennessee). Spatial patterns of spruce-fir forest tree species.

2:15 234. Busing, R.T. and E.E.C. Clebsch. (University of Tennessee). Two decades of change in an old-growth southern Appalachian spruce-fir stand.

2:30 235. Walker, J. and Robert K. Peet. (Southeastern Louisiana University and University of North Carolina). Structure and production in Atlantic and Gulf Coast savannas.

2:45 236. Pinder, J.E. III, F.B. Golley, P.J. Smallidge, N.J. Lambert and R.F. Lide. (Savannah River Ecology Laboratory and University of Georgia). Seed production, seed dispersal, seedling establishment and seedling survivorship of loblolly pine trees in secondary succession.

3:00 237. Pinder, J.E. III and K.W. McLeod. (Savannah River Ecology Laboratory). Contaminant transport due to the retention of soil particulates on plant surfaces.

3:15 BREAK

3:30 238. Nixon, Elray S., Gene A. Sullivan, Stanley D. Jones and Gretchen D. Jones. (Stephen F. Austin State University). Species diversity of woody vegetation in the Trinity River Basin, Texas.

3:45 239. Stephenson, Steven L. (Fairmont State College). Distribution and ecology of Myxomycetes in the upland forests of southwestern Virginia.

4:00 240. White, David A. (Loyola University of New Orleans, Louisiana). Sedimentation, plant colonization and succession on accreting mudflats within the Mississippi River delta--year 2.

4:15 241. Wu, Xinyuan and J. Frank McCormick. (University of Tennessee). Growth patterns of red spruce in an old-growth spruce forest in Great Smoky Mountains National Park.

4:30 242. Cunningham, Jackie and J. Frank McCormick. (University of Tennessee). Long term effects of ionizing radiation on a pine forest.

4:45 243. Jolls, Claudia L. (East Carolina University). The consequences of self-fertilization and the maintenance of gynodioecy in the bladder campion (Silene vularis).

PLANT SYSTEMATICS, SESSION II - Room J

Presiding: Dr. Robert R. Haynes, University of Alabama

1:30 244. Hunt, David M. (University of Georgia). Delimitation of taxa within the Quercus laurifolia/ Q. hemisphaerica complex.

1:45 245. Mularoni, Teresa C. and Charles E. Anderson. (North Carolina State University). An anatomical glimpse at the unusual root system of Liriope.

2:00 246. Macrander, A. Michael and Robert R. Haynes. (University of Alabama). Computer inventory of the vascular flora of Alabama.

2:15 247. Ballard, Robert E. and Colleen D. Crislip. (Clemson University). Leaf flavonoids of Actinidia.

2:30 248. Young, Elizabeth G. and Robert E. Ballard. (Clemson University). Flavonoid variation in Prunus persica cultivars.

2:45 249. McKinney, Landon E. (Vanderbilt University). Viola subsinuata Greene: a resurrected name for an old species.

3:00 250. Huck, Robin B. (Florida State Museum). Phytogeography of the endemic Labiates of the southeastern United States.

3:15 BREAK

3:30 251. Coile, Nancy C. (University of Georgia). SEM studies of Ceanothus seeds.

3:45 252. Rettig, Jeff H. (University of Georgia). Foliar flavonoids of the Carex pennsylvanica complex (Montanae, Cyperaceae).

4:00 253. Beckmann, Robert L. and George P. Johnson. (North Carolina State University and Lindsey Wilson College). Contribution of flavonoid constituents to the taxonomic treatment of the chestnuts (Castanea).

4:15 254. Werth, Charles R., A. Murray Evans and Donna M.E. Ware. (University of Kansas, University of Tennessee and College of William and Mary). Orphans in the woods: new records for the hybrid Dryopteris X Australis without its parents.

4:30 255. Garland, Mark A. (Florida State University). The phenetic relationships of Hieracium traillii Greene, a shale-barren endemic.

4:45 256. Jones, Samuel B. and Nancy C. Coile. (University of Georgia). St. Catherines Island, Georgia: a profile of floristic diversity as it relates to barrier island formation and human activities.

5:00 257. Methven, Andrew S. (University of Tennessee). The genus Clavariadelphus (Basidiomycetes, Aphyllophorales) in North America, excluding Mexico.

SYMPOSIUM - FIFTY YEARS OF MYCOLOGY IN THE SOUTHEAST

Main Auditorium

Presiding: Dr. Lafayette Frederick, Howard University

Titles and schedule will be available at meeting.

POSTERS

258. Ripley, Bruce, Doshie Webb, H. Wayne Elmore and Alan White. (Marshall University). A sustainable cell suspension culture derived from bracken fern root callus.

259. Gill, James P., Cheryl E. Williams, Mark B. Watson, Alan R. White and H. Wayne Elmore. (Marshall University). Polysaccharides in coconut milk.

260. Tannenbaum, Michael G., E. Bowie Kahle and Russel J. Reiter. (Marshall University and University of Texas, San Antonio). Effect of acute cold exposure on pineal biosynthetic function in rats.

261. Chen, D.T. and L. Frederick. (Howard University). Anatomical studies on phyllotaxy in young seedlings of the American elm (Elmus americana).

262. Sherrod, K.C., Thomas G. Ciravolo, and Kenneth W. McLeod. (Savannah River Ecology Laboratory). Growth of woody seedlings under varying light conditions.

263. Novak, James M.. (Savannah River Ecology Laboratory). Heterozygosity and sample sizes in population genetic studies of vertebrates.

264. Bratton, Susan P. (University of Georgia). Impacts of experimental poaching on pink lady slipper, Cypripedium acaule, and on common wood violet, viola papilionacea.

265. Lydeard, Charles and Michael L. Kennedy. (Memphis State University). Morphologic assessment of the coyote, Canis latrans, in Tennessee.

266. Prins, Rudolph and Rodney McCurry. (Western Kentucky University). Morphology of the male gonopod of freshwater asellid isopods.

267. Kelly, Mary Sauls. (Savannah River Ecology Laboratory). Leaf production and turnover in three co-occurring species of floating-leaved macrophytes.

268. Debiase, Adrienne E., Robert W. Sanders and Karen G. Porter. (University of Georgia). The impact of net zooplankton on bacteria-size particles in a monomictic lake.

269. Hunsinger, Ronald N., Barry Byram, and W. Mike Howell. (Samford University). Gonadal morphology in mosquitofish exposed to degraded plant sterols.

270. Webb, Doshia, Bruce Ripley, H. Wayne Elmore and Alan White. (Marshall University). Factors influencing growth and regeneration in bracken fern root callus.

271. Turner, Alan E. and Donald C. Tarter. (Marshall University). The effect of intermittent oilfield brine influences on benthic macroinvertebrate community structure in two headwater streams of the Pocatalico River, West Virginia.

272. Sera, Wendy E., C.H. Greenberg and Patricia D. Parr. (Earlham College, University of Tennessee, and Oak Ridge National Laboratory). Diet of the gray fox (Urocyon cinereoargenteus) and small mammal availability on the Oak Ridge National Environmental Research Park.

273. Gipe, Todd G. and John G. Morris, (Florida Institute of Technology). Effects of prescribed burning on the suitability of habitat for the Florida scrub jay, Aphelocoma coerulescens coerulescens.

274. Gettinger, Ronald D. and William H.N. Gutzke. (University of Alabama, Birmingham and Memphis State University). Influence of hydric environment on growth and metabolism of embryonic painted turtles.

275. Dindo, John J. and Ken R. Marion. (Dauphin Island Sea Laboratory, and University of Alabama, Birmingham). The influence of a major weather event on Cat Island, Alabama, a coastal heronry.

276. Coleman, Susan A., J Vaun McArthur and Laura G. Leff. (Savannah River Ecology Laboratory). Comparison of the decomposition of autumn and summer shed Acer rubrum in a coastal stream.

277. Oliver, James R. and Robert A. Stiles. (Samford University). Reproductive biology of the Cahaba shiner, Notropis sp., in the Cahaba River drainage, Alabama.

278. Zavos, P.M., D.R. Varney, L.P. Bush, R.W. Hemken, J.A. Jackson and M.R. Siegel. (University of Kentucky). Reproductive responses in male rats fed extracts of fescue seed infected by endophytic fungus (Acremonium coenophialum).

279. Zavos, P.M., D.R. Varney , J.A. Jackson, R.W. Hemken, M.R. Siegel and L.P. Bush. (University of Kentucky). Embryonic and fetal development in CD-1 mice fed endophyte infected tall fescue seed.

280. Zavos, P.M. Lactation in mice fed endophyte infected tall fescue seed.

281. Oakley, William E., Jr. (East Carolina University). Effects of oxidizing agents on flour beetle larvae.

282. Reed, Alan W. and Joe E. Winstead. (Lindsey College and Western Kentucky University). The sex life of flowers.

ABSTRACTS

1 through 3

Not available.

4

WEBB, MARK A. and FRANK J. BULOW. Tennessee Technological University--Effectiveness of a fish barrier in separating reservoir and tributary stream populations. Roaring River, a tributary of Cordell Hull Reservoir, Cumberland River, Tennessee, supports excellent smallmouth bass, rock bass, and redeye bass populations. Earlier studies demonstrated that: (1) tributary streams that were accessible from impoundments contained large populations of rough fish that moved upstream due to population pressure in the impoundment, (2) the quality and quantity of smallmouth bass and rock bass angling declined following the infiltration of rough fish into streams, and (3) mill dams over eight feet high appeared to be effective barriers to the upstream movement of rough fish. Prior to the closing of the Cordell Hull Dam, a rough fish barrier was installed on the Roaring River 4.9 miles upstream from its confluence with the Cumberland River. None of the 275 common carp, 268 golden redhorse, 144 gizzard shad, 62 black redhorse, 30 freshwater drum, and 12 smallmouth buffalo tagged below the barrier in 1985 and 1986 were recovered above the barrier. Pre-barrier and post-barrier species composition and standing crop estimates were compared. Similar comparisons were made for age and growth of 176 rock bass and 140 smallmouth bass.

5

STEPHAN, C. DIANNE and DAVID G. LINDQUIST. University of North Carolina at Wilmington --The effect of artificial reef structural parameters on fish community development. In February 1985 the construction of a trolling alley was initiated off the Cape Fear region of southeastern North Carolina. The trolling alley is located approximately 16.1 kilometers offshore in 18m of water. Two tugboats were sunk adjacent to a forty-year old dredge wreck, one 300m west of the dredge, the other 300m east of the dredge. On May 15, four vertical arrays of three McIntosh fish aggregating devices (FADs) were deployed approximately 300m east of the easternmost tug. Investigations into the fish community composition of the dredge and easternmost tug began April 15, 1985. FAD censusing was included after deployment. Censusing techniques involved SCUBA point censusing at various locations on the structures at irregular (weather permitting) intervals until FAD retrieval in December 1985. Censusing on the wrecks was completed in March 1986. A total of 48 species was seen on the structures collectively, with 2 common only to the FADs, 3 to the tugboat, and 5 to the dredge. The tugboat and dredge had more species in common (21), while 6 species were common to all three sites. The common species were all pelagics of which 3 (**Scomberomorus maculatus**, **Seriola dumerili** and **Sphyraena barracuda**) were targeted pelagic sportfish. Fish communities on the structure were noted to change with changing water temperature. The relationship between species present, available habitat, and seasonality is discussed with reference to reef productivity.

6

DE LA CRUZ, ARMANDO A. Mississippi State University--Amino acid content of naturally occurring estuarine detritus. Coarse fragments (≥ 1 mm) and particulate detritus (≤ 345µm) floating and suspended, respectively, in the estuarine waters of a marsh in St. Louis Bay in Mississippi, U.S.A. were analyzed for amino acid and crude protein concentrations. Total amino acid to crude protein ratios (0.90 to 0.95) in naturally occurring detritus is higher than what was previously reported for marsh plant detritus artificially decayed on the marsh. This indicated that organic detritus suspended in the water contained less non-protein nitrogen than detritus sedimented on the marsh surface.

7

RICHARDSON, JOSEPH P. Savannah State College--Georgia inshore marine algal flora: characteristics and relationships within the Carolinian biogeographic province. The Georgia coastline is characterized by environmental conditions that are generally not condusive to high benthic algal productivity and diversity. Recent studies, however, have revealed more than 60 species of benthic macroalgae from this coast. Multiyear collections made throughout the year, from a variety of substrata and habitats, presently allow phenological and diversity analyses of the flora for this portion of the southeastern coast. Species richness and abundance were generally greatest on floating docks, and almost no algae grew on subtidal substrata. Few Phaeophyceae were found. The flora was seasonal with greatest diversity during spring, however a distinct summer floral component was not obvious. Many of the most common species were present year-round. Five species appear to reach their southernmost distribution limit on the east coast in Georgia, and two species appear to reach their northernmost limit on the Georgia coast. Cumberland Island jetty supported a relatively rich diversity compared to all other locations in Georgia. This jetty site supported many species, especially Rhodophyceae, not encountered anywhere else along the Georgia coast. Additionally, this jetty flora was more similar to species assemblages outside of Georgia, eg. North Carolina, than it was to the remainder of the Georgia flora. Supported by NIH, MBRS Grant No. RR08144-11.

8

LEFF, LAURA G.[1], J VAUN MCARTHUR[1], and MICHAEL L. SCOTT[2]. Savannah River Ecology Laboratory[1] and Oregon State University[2]--Bacterial production in a thermally disturbed swamp.

Water samples were collected from three areas of a thermally disturbed swamp, Pen Branch Delta, on the Savannah River Plant. These areas differ in the degree of thermal disturbance. Samples were incubated at the temperature they were collected at for one hour with ^{3}H thymidine to determine bacterial productivity. Direct counts of bacteria were also made. The most disturbed habitat had significantly lower thymidine uptake than the least disturbed habitat (11509 and 37798 dpm/ml respectively). Seasonal patterns in the effect of disturbance on productivity were also examined. The differences in productivity may be indicative of differences in the degradation of organic matter in the three areas.

9

MCARTHUR, J VAUN and LAURA G. LEFF. Savannah River Ecology Laboratory--Effects of heating on the availability of nutrients to aquatic bacteria.

Heating of Savannah River water during the cooling of nuclear production reactors may increase the availability of nutrients to bacteria. The potential effect was monitored in laboratory experiments by examining bacterial growth rates in water that had been sterilized by: 1) autoclaving, 2) heating, or 3) cold filtering (0.2 μm). Bacteria inocula from the ambient temperature stream had significantly faster growth rates than bacteria isolated from the thermal stream when grown in heated or autoclaved Savannah River water. There were no differences in the growth rates between source of inocula in filtered water. NH_4 concentrations were significantly reduced during incubation by nearly 0.1 mg/L. Whereas there was very little change in NO_3 concentration, indicating the preferred nitrogen source. Heating appears to increase the potential for growth rates and suggests higher heterotrophic activity.

10

JAMES, R. THOMAS Institute of Ecology, University of Georgia--Changes in relationships between microbial and chemical factors in ten acid lakes of Florida.

Ten diverse subtropical acid lakes were sampled in July and October 1985. Bacteria numbers, Chlorophyll *a* concentration, pH, acidity, dissolved organic carbon (DOC), sediment organic matter, and other chemical factors were measured. Correlations between pH and bacteria, and chlorophyll *a* and bacteria were found in the July sample set, but these correlations were not as strong as those between the bacteria and DOC. These relationships changed in the October sample set. At this point the correlations were not as strong, however, multiple regression analyses indicated that pH and DOC accounted for a significant ($p < .10$) amount of variability in bacteria numbers. Comparison of these data sets show that chemical factors influence the microbiological community of lakes, these relationships are complex, the strength of the influences changes over time, and that long term monitoring is important in determining these relationships.

11

MCFADDEN, J. F., W. L. PENNINGTON, and E. L. MORGAN. Tennessee Technological University--Application of remote automated trout breathing rate monitoring device for assessing acid deposition events.

Automated biomonitoring provides a means for measuring *in situ* fish breathing rate changes to episodic rain events. The system discussed incorporates remote computer-assisted data collection platforms (DCP's) with satellite data retrieval options. A series of field trials were initiated to test *in situ* fish holding chambers and breathing rate monitors. Results were used in fabricating optimal in-stream holding chambers and trout breathing rate detectors. Six of these devices were implemented at each of two water quality DCP's located along Laurel Branch in the Southern Appalachian Mountains. In addition to continuously monitoring rainbow trout breathing rates, temperature, conductivity, pH, and flow were simultaneously logged on each DCP. These devices were positioned below and above a liming device on Laurel Branch, allowing us to assess the effects of episodic rain events and also the effects of mitigative liming in an acid rain stressed system.

12

MUEHLSTEIN, LISA University of Georgia--Observations of a wasting disease in eelgrass, *Zostera marina*.

Eelgrass is a widely distributed seagrass which is a well adapted and an ecologically important component of coastal and estuarine environments. A recent decline in eelgrass populations has been reported in the Northeast, (Short *et al.*, 1986, Mar.Ecol.Prog.Ser. 29:89-92.), similar to the eelgrass wasting disease of the 1930's. Surveys of eelgrass populations in the Pacific Northwest made during the summer of 1986, show disease symptoms similar to those associated with the recent east coast decline. From direct plating of the tissue on selective medium, the primary organism associated with the diseased tissue appears to be a species of the marine slime mold, *Labyrinthula*. Transmission electron microscopy shows *Labyrinthula* present in the epidermal and mesophyll cells of *Zostera marina*, while other fungi and bacteria are not. Healthy tissue shows no evidence of invasion by microorganisms, suggesting that *Labyrinthula* is the organism causing the disease, corresponding to what Renn (1936, Biol. Bull. 70:148-158.) found during the 1930's epidemic. This study represents an excellent opportunity to clearly identify the disease agent, study the host/pathogen interaction of the disease, and monitor the potential decline in the Pacific Northwest.

13

MAIER, CHRIS A. and ROBERT O. TESKEY. University of Georgia--Variations in net photosynthesis and water relations in mature white pine (*Pinus strobus*, L.) during a severe drought.

Net photosynthesis and water relations were measured in two age classes of foliage during the drought of 1986. Two twenty-nine-year-old stands of white pine from Watersheds 1 and 17 at the Coweeta Hydrologic Laboratory were sampled periodically during the growing season (April - October). In spring, prior to the onset of the drought, net photosynthesis rapidly increased in the morning to a peak rate which was maintained until late afternoon. Maximum net photosynthetic rates were primarily limited by low irradiance and temperature. Predawn xylem pressure potentials and absolute humidity deficits became the predominant variables affecting carbon gain and water relations as the drought progressed. In late July, during peak drought conditions, the rates of net photosynthesis and leaf conductance were greatly reduced. Maximum rates occurred in early morning and then decreased, approaching zero in the afternoon. Rainshowers in late summer initiated a partial recovery in photosynthetic capacity. Autumn diurnal patterns of net photosynthesis and conductance were similar to those in the spring. Maintenance of high photosynthetic capacity in older age classes of foliage coupled with mild winter conditions may help these trees cope with long and severe droughts.

14

TOWNSEND, ERIKA M., BERT M. CREGG and ROBERT O. TESKEY. University of Georgia--A comparison of physiological effects of drought on loblolly and shortleaf pine.

Net photosynthesis, leaf conductance and xylem pressure potential were measured diurnally on 10 days during the drought of 1986 on a site in Whitehall Forest near Athens, GA. The loblolly (*Pinus taeda*, L.) and shortleaf (*Pinus echinata*, Mill.) pine trees were six years old and had naturally regenerated on the study site after a disturbance. A group of each species was irrigated twice weekly and served as a control to compare with droughted trees. The drought had a significant effect on growth, net photosynthesis, leaf conductance, xylem pressure potential (XPP) and transpiration in both species. Mean daily XPPs were consistently lower in drought stressed shortleaf pines compared to drought stressed loblolly pines. However, often the irrigated loblolly pines had lower XPP than irrigated shortleaf pines. The drought reduced net photosynthesis similarly in both species, but patterns of water use differed. The relationship between stomatal and nonstomatal limitations to photosynthesis also differed between species and with severity of drought stress.

15

APSLEY, DAVID K., LINDSAY R. BORING, and ROBERT O. TESKEY. University of Georgia--Comparative water relations of *Liriodendron tulipifera* L. and *Robinia pseudoacacia* L. during a severe drought.

The responses of *L. tulipifera* and *R. pseudoacacia* to drought conditions were compared in an early successional forest in the Southern Appalachians. Xylem pressure potential (predawn and solar noon, XPP), transpiration and stomatal conductance (solar noon) of the two species were measured biweekly. Soil moisture levels dropped steadily from early June, reaching their lowest level of 14.5% in early October. The XPPs were most negative in early October for both species. *R. pseudoacacia* had XPP values of -0.97 and -2.1 MPa for predawn and noon, respectively. *L. tulipifera's* values were -0.59 and -1.3 MPa. Under driest conditions *R. pseudoacacia* had higher rates of transpiration (per unit leaf area) and higher stomatal conductances than *L. tulipifera*. Due to early leaf abscission, leaf area reduction was greater in *R. pseudoacacia* than in *L. tulipifera* during these periods. Greater variation in species water relations occurred at higher moisture levels. Species diurnal responses to changes in atmospheric variables interacted strongly with soil moisture conditions. These differences in seasonal and diurnal XPP, transpiration, stomatal conductance and leaf area indicate different mechanisms of drought tolerance for these species.

16

PLUMMER, GAYTHER. University of Georgia--1986-Drought: I. Physical aspects.

During 1979, cyclic patterns in precipitation monthly for all Georgia indicated a dry decade was imminent. Mid-1980 was expected to be the period of worst drought. Advisories were issued. In 1983, more refined studies used some fundamentals of astronomy and celestial mechanics to point more timely to a very severe drought "...before 1987". Additional warnings were issued. Shortfalls of rain for two years, a record-breaking drought beginning in December 1985, and a wayward high-pressure system in July 1986, all combined to produce a rare set of extremely-dry climatic conditions. Temperatures of 90+F during June and July stayed for an unusual number of days. In other years, more extreme temps and less rainfall occurred, but not together in springtime. Long-term droughts have been paired periodically: 1897 and 1903, 1925 and 1930, 1950 and 1954, then 1980 and 1984; each produced an overall rainfall-deficit that persisted 7 to 11 years in the form of a drought-trough, which included a short wet-period. Also, drought-periods occurred about 1740, 1820, 1904, and 1986; others came nearly 22 years apart, some at 11-years, a 7-year seriea is known, and more. Exact periods and precise cycles do not occur; nor should idealistic cycles be expected. Several driving mechanisms are involved each with different periods. Overlapping periods affect each other. Subsequently, more wet-periods than dry-ones are expected for 3 to 5 years with a rainfall peak about the turn of the decade. Precipitation could exceed 140 percent of normal during any 12-month period. During the next two decades or so, short-term droughts may occur aperiodically for reasons not yet clear. Nevertheless, an outstanding drought is expected cyclicly in the late-1990's -- about 1997-98.

17

PLUMMER, GAYTHER. University of Georgia-- 1986-Drought: II. Effects and impacts.
In Georgia, 30 people died compared with 95 during the dry-heat of 1980. Otherwise, impacts were most obvious within cultivated ecosystems; esp. on grasses, gardens, poultry, and swine. Sizes of grains, berries, nuts, etc., were smaller; yields during summer were much reduced. Irrigated vegetation responded variously; supplemental watering sustained crops but hardly met needs for growth. Among non-cultivars, some dry-land weeds flourished, aided by an occasional dew; smaller stature occurred. Soil-temps 4-inches deep at Blairsville attained 89 F; 8-inches at Tifton, 101 F. Upland biota were affected more severely than others. Food habits for many birds were modified during July. Roadkills of wildlife increased obviously. Juvenile toads, other amphibians, etc., had low survival rates; as did seedlings. All aquatic systems, esp. streams and farm ponds in the Piedmont, were affected. Still-waters stagnated; oxygen decreased fatally for some fish; algae flourished in many lakes with heat and increased concentrations of animal wastes. Also, organic decomposition was slowed noticeably during the driest weather. Full effects may not be known for months or years; if ever on shrimp, for example. Upland wells 350 ft deep in Hall county ran dry. August-rains halted the demise of animals and plants. Vegetation took water rapidly. As drought-stress was relieved, fungi and most grasses, esp. Cynodon sp., grew excessively. Some vernal-flora broke dormancy. Autumnal germination of winter annuals was prolific. Leaf-fall, persisted through November; coloration, brilliant. Surface waters remained low and steady until late-October.

18

PLUMMER, GAYTHER. University of Georgia-- 1986-Drought: III. Political and socio-economic biotics.
Drought-emergency plans formulated by state and local governments gave top-priority for water to health care, sanitation, and cooking needs. First-step conservation called for cuts in domestic water voluntarily; also restrictions on watering lawns. Second-steps involved enforcing restrictions; curtailed washing vehicles. Third-steps meant reducing water supplies for commercial and business purposes. In early-August, at least one community was without water for one day; some second-step enforcement did occur. By late-October, crop-losses in Georgia approximated 239.6 million dollars directly; not including depleted herds of livestock, dead poultry, etc., or indirect and delayed damages. Losses to wildlife and fish were not evaluated. Hydro-electric production was reduced at several large lakes. Those measures subtracted water from already low-flows in the Chattahoochee river below Columbus, which in turn caused commercial navigation to be suspended. Low-water levels in nearly all major reservoirs caused losses in recreational income. Well-drillers had backorders for eight or more weeks. Air-conditioning businesses soared. Construction in general progressed ahead of schedules, especially on new roads. Also, heat caused asphalt roads to deteriorate. Farm ponds constructed after previous droughts did sustain some livestock and pastures under best farming conditions; that kind of water did not relieve urgent needs of urbanized areas. Consequently, public awareness of potential water-shortages is enhanced; values of high-quality water are emphasized; networking among states to transfer water has been proposed. Federal legislation authorizing a re-regulation dam below Lake Lanier was signed in November; farm-benefits were stalled.

19

MYERS, RONALD L., SUSAN E. BOETTCHER, and HOLLY A. TUCK. The Nature Conservancy/Tall Timbers Research Station, and Archbold Biological Station--Sand pine (Pinus clausa) seeding response following fire.
Sand pine forms the overstory of xeric scrub vegetation on sandridges in Florida. Where stand-replacing fires recur every 20-80 yrs, a high percentage of the trees have serotinous cones. Seed rain in a 60 yr old sand pine stand with 73% serotiny was monitored for 1 yr pre-burn and 1 yr post-burn. Seedling establishment has been recorded since the fire. Background seed-fall occurs throughout the year but peaks in October-November when non-serotinous cones mature. Fire-induced seed release peaked in the first month post-burn and remained above the background level for 3 mos. Germination and seedling survival were highly dependent on rainfall and soil moisture. Two months after the fire there were 287 seedlings on plots totalling 250 m^2, but 91% mortality

occurred during a subsequent dry month. An additional 27 seedlings appeared during the next six months. The more recent seedlings probably derive from non-serotinous parent trees that survived the fire. Percentage of serotinous individuals in a stand may shift in response to site conditions following fire.

20

SHEPHERD, JOHN. Mercer University--Nectar thievery and reproduciton in the alpine wallflower, *Erysimum nivale*.

Ants (*Formica neorufibarbis*) are prominent flower visitors on the alpine tundra and nectar thieves of *E. nivale*. These ants are not effective in protecting plants against herbivorous chrysomelid beetle larvae, probably because of their intermittent presence on the plants. Although the plants are not able to compensate for beetle predation by mobilizing latent floral buds, they do increase fruit weight and lower abortion rates. Experiments show that this mustard depends on outcrossing for normal fruit set. Since the ants interact aggressively with other flower visitors, they may affect reproductive success directly. The ants reduce the average time spent on the inflorescence and number of flowers visited by 5 species of muscoid flies which are short range pollinators and nectar thieves. The ants have less effect on 2 bee species that are probably long distance pollinators. Exclusion experiments show that access by ants increases both fruit set and average fruit weight and thus has a net positive effect on plant success.

21

LUVALL, JEFFREY C. Earth Resources Laboratory, NASA--Using the TIMS to estimate evapotranspiration from a white pine forest.

I investigated techniques to use remotely sensed forest canopy temperatures from the Thermal Infrared Multispectral Scanner (TIMS) to estimate evapotranspiration (ET) from a coniferous stand at the Cowetta Hydrologic Laboratory (U.S. Forest Service). The use of intense, concurrent, ground based measurements of the physical (net and solar radiation; sensible and latent heat flux; vapor pressure deficits; wind, soil moisture) and physiological (stomatal conductance, leaf area index, canopy structure) parameters important for forests in controlling ET allowed for the comparison with the results obtained from a surface temperature model to those obtained using energy balance techniques. Three TIMS missions were flown on September 7, 1986 at the Cowetta Hydrologic Laboratory (U.S. Forest Service) in North Carolina. The timing of these missions coincided sunrise, solar noon, and sundown. Additional ground based measurements were taken (needle temperature; solar, net and long wave radiation; air temperature, wind, sensible heat flux, and stomatal conductance) to verify TIMS canopy surface temperatures. Results indicate that forest canopy temperatures measured by the TIMS are comparable to needle thermocouples temperatures. ET models developed from the TIMS data obtained similar ET rates as those using energy balance techniques.

22

HUPP, CLIFF R. and JOHN T. HACK. U.S. Geological Survey--White oak (*Quercus alba* L.) distribution in relation to bedrock and water availability, northern Virginia and Maryland.

White Oak (*Quercus alba* L.), a common forest species in eastern North America, is noted for having a broad ecological amplitude occurring on such places as sandy plains, gravelly ridges, rich uplands, coves, and well-drained terraces. However, white-oak distribution is not continuous throughout its range. A study was designed to test whether water availability or bedrock type was the more influential in white-oak site preference. Study sites were located from the Shenandoah Valley, Virginia, east to the coastal plain of Maryland. White-oak dominated forests were found over bedrocks of cherty limestone, shale, serpentinite, and alluvial hardpan. Regional vegetative and geologic mapping showed that forests with white oak largely absent could be found adjacent to the white-oak dominated forests where relatively minor lithologic differences in bedrock provided for increased and relatively constant water availability. Detrended Correspondence Analysis (DCA) of study sites suggests that near single-species stands of white oak can form over a wide variety of bedrocks. Forests strongly dominated by white oak indicate areas where there are shallow confining layers, wide fluctuations in soil moisture, and where areas are typically subject to summer droughts. Bedrock may be a primary determinant of soil characteristics; however, its influence on vegetation patterns appears to operate through the agency of soil moisture.

23

COLLINS, BEVERLY and JOHN E. PINDER, III. Savannah River Ecology Lab--Distribution of flowering forbs in a 35 yr old field.

Within a 35 yr old field on the coastal plain of South Carolina, woody species are scattered throughout a matrix of bunch grasses (*Panicum* spp. and *Leptoloma cognatum*) and short-lived forbs. We investigated the distribution of flowering forbs relative to bunch grass clumps in five 2 x 2 m plots established in both wet and dry areas of the field. Forb distributions were analyzed at 0 to 50 cm intervals from bunch grass centers. Neither spring- nor summer-flowering forbs were significantly clumped at any distance in either wet or dry sites. We conclude that, within a season, bunch grass clumps do not influence the distribution of flowering forbs in this old field.

24

SORENSON, JAMES C. Radford University--Diversity and abundance of V-A mycorrhizae in successional populations of *Andropogon virginicus*.

Degree of mycorrhizal infection of roots of *Andropogon virginicus* (broomsedge), and species diversity of mycorrhizal fungi within broomsedge roots and present in soil, were assessed for six old-field sites near Athens, Georgia. The six sites differed in time since abandonment and recent management history. Broomsedge roots from the three most recently abandoned, unmanaged sites showed more infection than roots from the oldest, unmanaged site and the two managed sites (frequently mowed and frequently burned). Species diversity of mycorrhizal fungi increased with increasing time since abandonment and was consistently greater in the soil than in broomsedge roots. Infection of sorghum roots (as a bait), however, was consistently greater from broomsedge roots than from the soil, except for samples from the most recently abandoned, unmanaged site. It is hypothesized that mycorrhizae play a role in the loss of dominance by broomsedge in successional communities.

25

YOUNG, DONALD R. Virginia Commonwealth University--Within branch leaf variations for the understory tree, *Asimina triloba*.

To investigate leaf structural, chlorophyll and nutrient differences on terminal branches of the understory tree, *Asimina triloba*, the first (proximal) and the last (distal) leaves to develop in the spring were compared. Proximal leaf expansion was completed before the overstory canopy was fully closed but distal leaf expansion occurred during and after the development of the overstory canopy. Fully expanded proximal leaves were 76% smaller and 18% thicker, but had 36% more stomates per m^2 of leaf area when compared to distal leaves. In addition, maximum stomatal conductance to water vapor was greater(150 vs 120 μmoles m^{-2} s^{-1}) and the PPFD required for maximum conductance was higher (200 vs 150 μmoles m^{-2} s^{-1}). Chlorophyll contents were also greater in proximal leaves,but nitrogen and phosphorus concentrations (% of leaf dry weight) were lower throughout the entire summer. Seasonal measurements indicated an increase in chlorophyll *a* concentration and reductions in nitrogen content throughout the summer growth period for leaves from both positions. The results suggest that distal and proximal leaves differed physiologically and that the measured differences were related to the changing irradiance environment during leaf development. Leaf position on the branch may be an important consideration when examining the water and photosynthetic relations of understory trees.

26

SMITH, WINSTON PAUL and S. WEST HAGG. Tennessee Technological University and Southeastern Louisiana University--Plant communities within commercial timberlands of the upper Florida Parishes, Louisiana.

Two replicates of regeneration stands within southeastern Louisiana commercial timberlands were characterized according to species composition, May-September 1983 and June-July 1985. *Panicum* spp., *Andropogon* spp., *Rubus* spp., *Aster* spp., *Lonicera japonica* and *Diodia teres* were common in the understory of all pine plantations; *Helianthus angustifolia*, *Stylosanthes biflora* and *Tephrosia virginiana* were common in ≤ 6 year-old stands while *Elephantopus* spp., *Smilax* spp., *Solidago* spp., *Lespedeza* spp., *Mitchella repens*, *Gelsemium sempervirens* and *Rhus radicans* were common in older stands. In hardwood forests, the 5 most common groundcover species were *M. repens*, *Uniola laxa*, *L. japonica*, *Hamamelis virginiana* and *Liquidambar styraciflua*. *Pinus taeda*, *L. styraciflua*, *Rhus copallina*, *Callicarpa americana*, *Acer rubrum*, *Carya tomentosa*, *Prunus serotina*, *Quercus* spp., and *Vaccinium* spp. were common woody species in the mid-story and overstory of pine plantations. Dominant associates in hardwood forests included *Oxydendrum arboreum*, *Quercus alba*, *Q. nuttallii*, *L. styraciflua* and *A. rubrum*. Vertical vegetation density was greatest in 3-7 year-old stands. Canopy cover was $\geq 89\%$ and stem density was ≥ 982 stems/ha in all older forests except 10 year-old pine stands, which recently experienced prescribed burning. Community structure differed among stands: species richness and diversity were highest in recent clearcuts and declined with age; the trend in richness reversed in stands ≥ 7 years old while diversity reversed in stands ≥ 5 years old. The 2 oldest pine stands and hardwood forests exhibited the greatest evenness.

27

WADE, GARY L. Northeastern Forest Experiment Station, U. S. Forest Service--Species, soil, and community effects on plant nutrient concentrations.

Nutrient concentrations in plant species in three pioneer communities on two surface-mine spoils were compared to determine differences in plant nutrition as influenced by species, soils, and community. Species used were those common to at least two of three communities established on two surface-mine spoils in microplots. Communities were a reclamation mix of three grasses plus lespedeza, a native species mix from a forest topsoil seed bank, and a seed bank plus reclamation mix. Among native species, N, P, K, Ca, Mg, Mn, Fe, Cu, and Zn varied significantly between species; spoil/soil affected levels of N, Ca, Mn, Fe, and Zn; and community membership affected concentrations of N, P, K, Ca, Mn, Fe, and Zn. Concentrations of N, P, K, Ca, and Zn generally were higher in native species that were repressed by the reclamation mix. Reclamation mix species varied significantly between species for all elements except Fe. Reclamation mix species were less responsive to soil and community influences. Dicots generally were more influenced by presence of grasses than grasses were by dicots.

28

HARDIN, JAMES W. and SUSAN L. SHERMAN. North Carolina State University and University of Georgia--Foliar surface features of the American Elms (Ulmus).

Leaf surfaces of the six native and two cultivated elms have been examined with SEM. The cuticular patterns and epicuticular waxes appear to be somewhat variable. Four trichome types are identified: (1) bulbous--small, glandular, 1-5 celled; (2) clavate--elongated, single-celled, thin-walled, widest at or above the middle; (3) subulate--single-celled, sharp-pointed, tapered from a broad base, thick-walled, variable in length and orientation; (4) acicular--long, single-celled, slender, thin-walled, straight or curled. All the species examined have the same trichome complement but differ in vestiture. The size and orientation of the subulate trichomes account for the "smooth" vs. "rough" surfaces characteristic of the species; the acicular type forms the conspicuous "fine" or "soft" hairs found on the leaves.

29

SHERMAN, SUSAN L. University of Georgia--Multivariate analyses in the genus Ulmus L. in eastern North America.

Twenty-two foliar flavonoids and twenty-two vegetative morphological characters were analyzed in the six species of Ulmus indigenous to eastern North America. Principle component and cluster analyses were used to determine if these characters were useful in distinguishing relationships among these taxa. The flavonoid results indicate that the four species with corky bark, (U. alata Michx., U. crassifolia Nutt., U. serotina Sarg., U. thomasii Sarg.) may be closely related, transgressing past sectional treatments, and are easily distinguished from the other two taxa (U. americana L. and U. rubra Muhl.). The morphological results show that the species are difficult to distinguish. This implies that a comprehensive re-evaluation of the floral and fruit morphology is necessary to determine if flavonoid chemistry does indicate a better treatment.

30

RUSHING, ANN E. and ROLAND R. DUTE. Auburn University--Pit membranes with tori in the wood of Osmanthus americanus (L.) Benth. & Hook. ex Gray.

Intervascular pit membranes with thickenings known as tori are common in many species of gymnosperm wood but until recently were thought to be absent from the wood of dicotyledonous angiosperms. In 1978, investigators reported tori from the wood of four Japanese species of Osmanthus, a genus in the Oleaceae. With the aid of scanning electron microscopy we now report the presence of bordered pit pairs with tori connecting vessel members in Osmanthus americanus, the only native American species of this genus. Each bordered pit pair contains a pit membrane with a centrally located thickening or torus approximately 2.5 µm in diameter. In air-dried material, the membrane surrounding the torus (the margo) consists of fine fibrils embedded in a matrix. Fixation in alcohol removes much of the matrix, thus clearly exposing the fibrous component. In some instances, the torus of a pit membrane is pressed against one of the pit apertures. In a living branch this valve-like action of the torus would probably isolate a damaged, air-filled vessel from its neighbors. Thus, in both form and function, the torus-bearing bordered pit pairs in O. americanus resemble those in many gymnosperms.

31

TOBE, JOHN D. AND JOHN E. FAIREY, III Clemson University--The Vascular Flora of the Chauga River Drainage, Sumter National Forest.

The Chauga River Drainage is located in north-west South Carolina almost entirely along a Paleozoic fault, the Brevard belt. The area's topography, physiography, soil, climate, land-use history and previous floristic studies will be discussed. The vascular flora of the area is rich in species with both Coastal Plain and Appalachian affinities. Rare, indigenous, introduced and disjunct species will be noted, e.g. Trichomanes boschianum Sturm ex Bosch, Trichomanes petersii Gray, Stewartia ovata (Cav.) Weatherby, Lysimachia fraseri Duby and Echinacea laevigata (Boynton & Beadle) Blake. A two-year taxonomic study of the vascular flora on the 7700 ha. river gorge was initiated in March of 1986 and continues into 1987. A preliminary annotated list of more than 430 species representing 101 families has been compiled. Broad vegetational assemblages have been recognized and described. Unique areas such as acidic rock seepages and granitic outcrops will be noted.

32

Currie, H. and Samuel B. Jones. University of Georgia--Leaf flavonoids of the native species of Hosta (Liliacene).

All previous classifications of Hosta have relied solely on morphological data resulting in numerous interpretations of the classification of the genus. In an attempt to provide additional insights, leaf flavonoids from 20 species of Hosta (Liliaceae) were analyzed for potential use as chemotaxonomic characters. Flavonoid surveys revealed species specific profiles in many of the taxa examined. Seventeen phenolic compounds were detected collectively within these species, with eight compounds being identified as flavonoids. The majority of species were found to have various glycosides of the flavonol, kaempferol, with three of these being identified as kaempferol 3,7 diglycoside (galactose, glucose), and kaempferol 3,7 diglucoside, and kaempferol 3,7 triglycoside (galactose, glucose, and rhamnose). Certain species were found to contain a partially identified flavone. Results suggest that chemical data may be useful as a framework for reevaluating morphological distinctions among Hosta taxa which may lead to clarification of interspecific relationships within the genus. Flavonoid profiles were also obtained from the leaves of several species from genera believed to be closely related to Hosta including Agave, Camassia, Hemerocallis, Hesperocallis, Leucocrinum, and Yucca. Results indicate greater similarity of Hosta with Hesperocallis than with the other genera under consideration.

33

CHUNG, MYONG GI and SAMUEL B. JONES. University of Georgia--Pollen Morphology of Hosta (Liliaceae) and Related Genera.

The genus Hosta lacks a biologically meaningful classification. Above all a clear understanding of what may be the most closely related genera to Hosta is a matter of debate. Hesperocallis, Leucocrinum, Agave, Yucca, Camassia, and Hemerocallis have all been considered in the past. The pollen grains of Hosta and the nearby genera have been examined by LM, SEM, and TEM in an effort to provide new evidence useful in classification. The pollen grains of Hosta are spherical and inaperturate, with the exception of H. plantaginea with spherical, monocolpate-type. Three types of exine sculpturing in Hosta are recognized: reticulate-type; corrugate-type; and granulate-type. The exine sculpturing, aperture type, shape, and size of H. plantaginea is very similar to those of Hesperocallis undulata. The results from this study provide useful information for developing a more meaningful biological classification of the genus and assist in its placement among the lily line of monocots.

34

SMITH, GERALD L. and WALTER S. FLORY. Wake Forest University--Cytological reexamination of Hymenocallis Salisb.

Hymenocallis, consisting of approximately fifty species, is an entirely American genus of the Amaryllidaceae widely distributed in the warmer parts of North America and the Neotropics. Morphological and cytological variability, in this distinctive genus, makes for confusion when determining species relationships. Significant morphological and, especially, cytological information for the genus has been amassed by Flory, his students and associates. Diploid numbers of 46 with 23 being a basic number predominate, but x=20 (2n=40) also appears as a lesser basic number. Aneuploidy resulting from centric fission is widespread, with many aneuploids appearing to have been derived from taxa with either 2n=46 or 2n=40. Preliminary field studies and accompanying cytological and morphological studies, especially of the diverse native Floridian taxa, now give promise of information providing additional taxonomic understanding of this complex genus.

35

BROYLES, STEVEN B., ROBERT WYATT, WILLIAM M. HOUGHTON, MARY JO GODT, SUZANNE KOLB, and ROGER LAUSHMAN. University of Georgia --The breeding system of Zephyranthes atamasco (L.) Herbert.

We studied the breeding system of the Atamasco Lily, Zephyranthes atamasco which is a long-styled, bulbous perennial native to moist woods in the piedmont and coastal plain of the southeastern United States. Controlled pollination and bagging techniques showed that Z. atamasco is a self-compatible plant with possible low levels of autogamy. Seed number per capsule (19.1 ± 0.8; mean ± standard deviation) was lower than potential seed number as measured by number of ovules per ovary (52.5 ± 11.7). Seed number for flowers that were cross-pollinated by hand (24.8 ± 14.0) was significantly higher than for open-pollinated flowers (13.4 ± 7.3), but was not significantly different from seed number for flowers that were self-pollinated by hand (19.4 ± 9.9). Average seed weight was significantly higher for open-pollinated (21.3 ± 7.9 mg) flowers versus flowers that were self-pollinated (13.1 ± 6.0 mg) or cross-pollinated (14.3 ± 6.4 mg). Percent germination was significantly higher for seeds resulting from self-pollination (53 ± 34%) and cross-pollination (63 ± 27%) versus open-pollinated seeds (32 ± 23%). The usual coupling of self-incompatibility and long styles observed in other taxa of Zephyranthes appears not to be true for Z. atamasco. Although positional barriers may limit self-pollination in Z. atamasco, it appears that self-pollination reduces neither seed number nor germination success.

36

PITTMAN, ALBERT B.
Arkansas Natural Heritage Commission
Systematic studies in Scutellaria section Mixtae (Labiatae)

The systematic relationships in the section Mixtae Epling were investigated by means of (1) chromosome counts (2) photographic spectral analysis of floral coloration and corolla nectar guides (3) standard herbarium studies of morphological variance and nomenclature and (4) statistical analysis of variance within and among selected taxa.

The following chromosome numbers were determined: S. cardiophylla Egelm. and Gray n=24, S. saxatilis Riddell n=15, and the S.

ovata Hill complex n=10, indicating a group with polyphyletic origins. Photographic spectral analysis of nectar guides on the lower lip of the corolla were used to qualify floral color components across the human and insect visual spectra. No "invisible" longwave UV patterns were recorded. Nectar guides patterns in both spectra were found to be useful characters at the specific and subspecific levels. These patterns plus corolla shape were used to build the classification framework for the *S. ovata* complex below:

(1) subsp. *ovata*
(2) subsp. *bracteata* (Benth.) Epling
    var. *bracteata*
    var. *texana* var. Nov.
(3) subsp. *rugosa* (Wood) Epling
    var *rugosa*
    var *rugosa* var. *arguta* Buckley
      comb. Nov. .

Differences in floral characters were seen to be particularly important in light of the fact that the ANOVA revealed very little divergence of these taxa relative to quantifiable herbarium material.

37

STALTER, RICHARD.[1] St. John's University and ERIC LAMONT.[2] St. John's University.[1] New York Botanical Garden.[2] *The Vascular Flora of Hempstead Plains, Long Island, New York.*

The vascular flora of Hempstead Plains, New York was surveyed on a weekly basis from April 12, 1986 to October 15, 1986. The flora contains 172 species in 120 genera and 50 families. The largest families are Poaceae (33 species) and Asteraceae (32 species). The largest genera are *Panicum* and *Solidago*. *Agalinus acuta* and *Polygala nutallii* are the rarest taxa. The vegetation is rich in monocotyledons and forbs. Thirty eight percent of the flora are alien taxa. A history of land use and invasion of alien species will be presented.

38

MARTY, REBECCA S. and MICHAEL P. SCHAFALE. Duke University, and North Carolina Natural Heritage Program--*Determination of the natural communities of a blackwater river swamp system.*

The natural community composition of blackwater river floodplains has not been clearly defined. In conjunction with a natural areas survey of the Waccamaw River basin in North Carolina, the natural communities of the entire floodplain were explored using aerial photography and field research. We sampled two sites containing examples of most of the communities of the basin to give a more precise picture of these natural communities and their structures. We identified nine natural community types with seventeen subtypes. There were also six human-altered communities. The color and texture signatures for each community type and subtype were accurate for all areas ground truthed through the entire river basin. This analysis was used to create a map showing the natural community types of the basin. The natural community types are more diverse in vegetation than previously thought typical of blackwater river basins. The literature suggests that this river was a large brownwater river 75,000 years ago. This ancestral river may account for the unusual geomorphic and topographic features responsible for the unusual and diverse natural community types.

39

TUPACZ, EDWARD G. and FRANK P. DAY JR. Old Dominion University --*Root decay rates in the periodically flooded Great Dismal Swamp*.

Root decomposition rates on four sites were estimated by a modified litter bag technique and a core method. Litter bags 40cm long divided into four 10cm sections were vertically implanted on each of the four sites. In addition, 10cm reciprocal bags with root litter from each of the three other sites were implanted. No significant differences were found between depths in the litter bags; however, there was a trend of decreasing decay rates with increasing depth. Comparisons of litter types among sites showed no effects due to environmental differences, but litter type did affect decay as roots from the cedar and mixed hardwood sites were more resistant to decay than those from the cypress and maple-gum sites. The core method exhibited decay rates of up to 85% / year for the <2mm roots on the maple-gum site, whereas the litter bags only had rates of up to 35 - 40% / year.

40

MEGONIGAL, J. PATRICK and FRANK P. DAY. Savannah River Ecology Laboratory, and Old Dominion University--*Cypress root decay in a flooded organic soil: A mesocosm approach*.

The influence of flooding on belowground processes in forested wetlands is poorly understood and difficult to study experimentally. We are using large experimental mesocosms to investigate the effects of flooding on the decomposition of cypress roots in a typical southeastern organic soil. Treatments are continuously flooded and seasonally flooded. Litter bags containing fine cypress roots were designed to integrate decay losses over 20 cm depth increments to a total depth of 60 cm. Weight loss was determined from bags collected at two month intervals. After two and four months there were no significant differences in decay losses between treatments or between depths within a treatment despite clear differences in soil oxygen levels and redox potential. Decay losses averaged 15% during the first two months and 3% during the second two months. Apparently, leaching accounts for most of the decay losses to date.

41

WEST, SUSAN K. and FRANK P. DAY. Old Dominion University--Root production in the periodically flooded Great Dismal Swamp.

A biomass difference method using soil cores was utilized to obtain estimates of root biomass and production on four sites in the Great Dismal Swamp. Initial observations indicated greatest amounts of biomass were produced on the mixed hardwood site. This was probably the result of favorable aeration and water availability on this site. Low fine root production on the cypress site is best explained by high water levels in the winter and spring and compact clay soils. Nearly one-third the total root mass on the maple-gum site was necromass. This was probably related to high mortality caused by higher water levels during the growing season. On all sites, root biomass decreased with increased depth. An implanted soil mass technique was also employed from late July to early December, 1985, to estimate root production. No direct comparisons of the two methods were made because of differences in the time of year these production values represent. Production was greatest on the mixed hardwood site and lowest on the maple-gum site. Overall, these findings indicated an extremely dynamic belowground component in the Great Dismal Swamp.

42

DAY, FRANK P., SUSAN K. WEST, and EDWARD G. TUPACZ. Old Dominion University -- Ground water dynamics in four communities in the Dismal Swamp.

Hydroperiod is perhaps the most critical factor in periodically inundated systems in controlling production, decomposition, and other dynamic processes. Water levels on four intensively studied sites in the Dismal Swamp were continuously recorded in 1.3m deep ground water wells. The period of flooding above or near the soil surface was longer in 1986 (5.5 months) than in 1985 (4 months). The rise and fall of water levels tracked about the same on all sites throughout the year, but there were large differences in depths. During the wetest part of the year, the order of flood depth was cypress > maple-gum > cedar > mixed hardwood. However, the water level on the cypress site dropped precipitously in the summer. Water levels were highest in the spring and summer on the cedar site, which stayed wet near the rooting zone throughout the year. The hydrologic patterns are related to measured process rates on these sites.

43

DAVIS, MARY M. and G. RONNIE BEST. University of Florida -- Success criteria for created wetlands in Florida.

The State of Florida has proposed a mitigation rule for success criteria of created wetland communities. The floristic requirements are to meet permit conditions for composition, diversity, survival and areal coverage of target species. Permit conditions specify time limits to meet these requirements. The oldest mitigated wetland communities on phosphate mined lands are only 7 years old, yet a reasonable time limit to establish a self-sustaining community must be estimated. Changes in height average -3.99-16.28 cm/yr and survival rates average 7-70% for several tree species planted in reclaimed wetlands on phosphate mined lands. Growth and survival rates may be improved in future sites with better placement of species in relation to hydrologic regime. However, these data suggest that the cost of diversity requirements is to increase the time required to meet other permit conditions.

44

SEGAL, DEBRA S., CHARLOTTE PEZESHKI, and G. RONNIE BEST. Center For Wetlands, University of Florida--Relationship between wetland soils and wetland vegetation in the Osceola National Forest.

The degree to which wetland soils support wetland vegetation was investigated. Soil types in the Osceola National Forest, Florida were identified and described. Vegetation quadrats were constructed at each study site to characterize overstory, shrub, and herbaceous stratum. A wetland index, designed to quantitatively rank vegetative species according to their importance value and hydrological tolerance, was compared to a soil moisture gradient. Wettest soils, indicative of cypress/gum swamps, possessed a significantly lower wetland index for canopy, short shrubs and herbaceous species than the flatwood or upland soils. Wetland index for tall shrubs was not significantly different due in part to proliferation of *Lyonia lucida*. The two flatwood soils, which are on the hydric soils list devised by the National Technical Committee on Hydric Soils, supported primarily transitional vegetation. No significant difference in wetland index was noted between flatwoods and uplands for trees and short shrubs. The information derived from this study is designed to facilitate the development of the USFWS Wetlands Classification System. Additionally, it will improve the multiple parameter approach to delineation of wetland boundaries.

45

PECHMANN, JOSEPH H. K., DAVID E. SCOTT, J. WHITFIELD GIBBONS, and RUTH ESTES. Savannah River Ecology Laboratory--*Refuge ponds: An experiment in wetlands mitigation*.

A significant function of wetlands is that many provide critical habitat for amphibian breeding and larval development. Many amphibian species are philopatric, returning to the same breeding site each year. Few data exist on the response of amphibian populations when wetlands are impacted or eliminated by man. If replacement wetlands are built as mitigation, it is unknown how rapidly, if at all, amphibian species colonize the new site. When a Carolina bay was eliminated on the Savannah River Plant in South Carolina by construction, we began an experiment to address these questions. Four shallow ponds were dug around the periphery of the construction site and left to undergo natural colonization and succession. The number of amphibians entering these ponds to breed and the number of metamorphosing juveniles produced were monitored using terrestrial drift fences with pitfall traps. *Bufo terrestris*, *Hyla crucifer*, *Hyla gratiosa*, *Hyla chrysoscelis/versicolor*, and *Rana utricularia* readily colonized the ponds, and their larvae successfully developed through metamorphosis. Salamanders such as *Ambystoma talpoideum* and *Notophthalmus viridescens* at first continued to return to the former site of the Carolina bay. After two years, however, these species also colonized the refuge ponds and successfully bred in them.

46

ERWIN, KEVIN L. Consulting Ecologist, Inc. -- *Distribution of macroinvertebrates in four small isolated freshwater marshes in Southwest Florida*.

Isolated freshwater marshes are a predominant wetland landscape feature in southwest Florida. These depressional wetlands, which are located throughout the region's pine flatwoods and agricultural lands, provide surface water storage and important fish and wildlife habitat. The role of macroinvertebrates within these systems is poorly understood and may have significance with regard to the character and wildlife utilization of a marsh. Four isolated freshwater marshes were sampled for macroinvertebrates to determine the distribution of species within each marsh and the different macrophyte communities. The marshes, located in eastern Lee County, are all shallow depressional wetlands within an area of improved pasture. The major macrophyte communities include *Cladium jamaicensis*, *Hypericum galioides*, *Panicum hemitomon*, *Polygonum* spp., *Centella asiatica*, *Stillingia sylvatica*, *Bacopa* spp., *Utricularia purpurea*, *Sagittaria subulata*, *Pontederia lanceolata* and *Thalia geniculata*. Qualitative dip net samples were collected along transects bisecting each marsh. A total of 47 species (35 aquatic insect species) were identified. Observations are made regarding the degree of similarity of species in each marsh and within the major macrophyte communities. Low similarity of species between marshes is apparently a function of macroinvertebrate compartmentalization within certain macrophyte communities.

47

DELCOURT, PAUL A.,[1] HAZEL R. DELCOURT,[1] DAN F. MORSE,[2] and PHYLLIS A. MORSE.[2] University of Tennessee[1] and Arkansas Archaeological Survey[2] -- *Vegetation history and prehistoric human impacts in the southeastern United States*.

Modern patterns of distribution and composition of Southeastern plant communities are a consequence of climatic changes over the past 20,000 years and of human activities in the last 12,000 years. During the last full-glacial interval (20,000 to 16,500 yr B.P.), a sharp ecotone at 34°N separated boreal forest and tundra to the north from temperate vegetation on the Gulf Coastal Plain. During late-glacial times (16,500 to 12,500 yr B.P.), ephemeral plant communities with compositions unlike those found today developed in the zone of northward species migrations north of 34°N. Eastern deciduous forests have become widespread only in the past 10,000 years, and southern pines have dominated on the coastal plains for only the past 6000 years. Through swidden agriculture, particularly in the last 5000 years, prehistoric human populations have affected the vegetation of the Southeast by (1) changing the relative dominance of tree species; (2) extending and truncating species ranges; (3) providing new disturbance regimes for invasion of ruderals; and (4) altering the landscape mosaic of forest and nonforest vegetation types.

48

ASH, ANDREW N.,[1] STEVEN L. STEPHENSON,[2] and DEAN F. STAUFFER.[3] Gardner-Webb College,[1] Fairmont State College[2] and Virginia Polytechnic Institute and State University[3]--*Appalachian oak forests*.

Appalachian oak forests occur in the Blue Ridge and Ridge-and-valley provinces of the Southern Appalachian Mountains. Most stands have succeeded from oak-chestnut

(*Castanea dentata*) forest. Regional rainfall is 90-200 cm and average monthly temperatures vary between 2°C and 23°C. Geology is complicated and involves repeated uplift, baseleveling and erosion. Principal soil orders are Ultisols and Inceptisols. Human disturbance and loss of dominant chestnut trees are important determinants of present vegetation patterns. A regional order of most important trees in oak communities might be as follows: *Quercus rubra*, *Q. prinus*, *Carya* spp., *Q. alba*, *Acer* spp. and *Betula* spp. A similar order for mixed-mesophytic communities is as follows: *Acer saccharum*, *Fagus grandifolia*, *Tilia* spp., *Carya* spp., *Liriodendron tulipifera*, *Fraxinus americana*, and *Tsuga canadensis*. About 228 terrestrial vertebrates live within the region: 43 amphibians, 32 reptiles, 83 birds and 70 mammals. The region is a center of North American salamander diversity and has many boreal disjuncts. The summer avifauna is dominated by neotropical insectivores while winter avifauna is mostly northern disjuncts or non-migratory granivores. The Rodentia are the most common mammal group and the white-tailed deer (*Odocoileus virginianus*) the most important species. Land use categories as a percent of total land in 1980 (% change since 1900) are as follows: upland forest 79%(+13%), bottomland forest 1%(0%), cropland 13%(-13%), pasture 3%(-2%) and developed land 4%(+2%). Land use trends include decreased farming, increased forest use, static mining, increased second home/vacation use.

49

HINKLE, C. ROSS. The Bionetics Corporation, John F.Kennedy Space Center, Florida--*The Mixed Mesophytic Forest Region.*

The area defined as the Mixed Mesophytic Forest Region lies, for the most part, within the boundaries of the unglaciated portion of the Appalachian Plateaus Province. Extending from its center of greatest development in the Cumberland Mountains of southeastern Kentucky, it has been classically mapped as far north as southern Ohio and Pennsylvania and as far south as northern Alabama and Georgia. Moving away from its center of development, vegetation similar to that characterized as Mixed Mesophytic is restricted to rich sites and protected areas such as middle and lower slopes of the highly dissected plateau. Studies on a major part of this physiographic province, the Cumberland Plateau of Tennessee, show that the predominant vegetation cover is characteristically mixed oak forests on flat to rolling uplands and richer oak forests on slopes of the dissected surface. Major environmental factors related to the plant community distribution on flat to rolling uplands are soil depth, slope position, and available water, while the major factors in gorges, ravines and other protected areas are soil pH, bedrock type, soil nutrient, slope position, and the degree of protection.

50

BURBANCK, MADELINE P. Emory University--*Vegetation of granite outcrops in southeastern United States.*

Exposed monadnocks, slopes and flat areas of granitic rock in Piedmont region from Alabama to Virginia support plant communities characterized by species able to survive harsh environmental conditions. A high degree of endemism is present, particularly in north central Georgia where the greatest concentration of granite outcrops is found. Distinctive plant communities occur in seven types of habitats: exposed rock, shallow pools, seepage areas, rock crevices, shallow soil-filled depressions, vegetation mats and marginal ecotonal areas. Intensive study of shallow soil communities at Arabia Mountain, Georgia and nearby outcrops reveals that with increasing soil depths the vegetation of these "island communities" is undergoing succession from a lichen-annual herb community to an herb-shrub or shrub-tree stage. In northeast Georgia and North and South Carolina, mat communities dominated by *Grimmia* appear to be the more usual early successional stage. The unique flora of granite outcrops is threatened by quarrying, road building, real estate development and careless recreational use, but acquisition and management by local, state and national conservation organizations are assuring survival of many ecologically valuable sites.

51

DOERR, PHILLIP D. North Carolina State University -- *Animal communities of the southern mixed hardwood forests.*

The once widespread mature pine forests of the southeast are amazingly diverse communities that presently occupy about 10% of the historical range. This highly specialized, fire adapted community supports a unique flora and fauna that has been substantially reduced in this century. Fire suppression and short rotation silviculture have contributed substantially to the loss of this forest type. This paper reviews the current status of the fauna and the unique relationships of such species as red-cockaded woodpeckers (*Picoides borealis*), fox squirrels (*Sciurus niger*), gopher tortoises (*Gopherus polyphemus*), longleaf pine (*Pinus palustris*) and wire grass (*Aristeda stricta*). While commonly occurring species are discussed, the focus is on the prevalence of rare, threatened or endangered faunal elements and the co-evolution of plants and animals of the longleaf forests. The dependence of red-cockaded woodpeckers on mature longleaf for both nesting and foraging, the association of fox squirrels with large cones of longleaf and a possible role of the squirrels in longleaf growth through dispersal of mycorrhyzal fungi are explored. The precarious status of this unusual biotic community is argued.

52

RICHARDSON, CURTIS J. and J. WHITFIELD GIBBONS. Duke University and Savannah River Ecology Laboratory--*Pocosins, bogs and bays*.

Pocosins - nutrient poor, freshwater, evergreen shrub bogs - were developed by peat accumulation and blocked drainage over the past 10,000 years. They once covered 1.2 million ha on the southeastern coastal plain of the U. S. Carolina bays have pocosin type vegetation, are of unknown origin, variable in size (1 ha to several thousand) and are most often found on sandy soils with elongated, elliptical depressions on a NW-SW axis, with a high sand rim to the SE. An analysis of their geological origin, ecological value, soils, and vegetational and animal communities is presented along with a status report on development trends.

53

FRAZER, NAT B.[1], JUDITH L. GREENE[2] and J. WHITFIELD GIBBONS[2] Mercer University[1] and Savannah River Ecology Laboratory[2]--*A test of Fabens' growth interval model using data on a long-lived species, Trachemys scripta*.

The Fabens growth interval equation provides a method for estimating von Bertalanffy growth equations for animals of unknown age. The method has been used to provide growth curves for a number of vertebrate species, but to our knowledge it has not been tested by comparing the results to those obtained using data from animals of known age. In this paper, we tested the Fabens growth interval methodology using data on 70 wild female *Trachemys scripta*. First, measurements at capture and recapture were used to fit a Fabens growth interval equation, under the assumption that ages were unknown. Because it is possible to age individual *T. scripta* by counting growth annuli on the scutes, a von Bertalanffy growth equation also was estimated directly using known age data. Parameters of the von Bertalanffy equations estimated by the two methods did not differ significantly. Similar results were obtained with male *T. scripta*. Thus, we conclude that the Fabens model can provide accurate estimates of growth curves for studies in which the ages of organisms are impossible or difficult to determine.

54

Crouse, Deborah T. and Larry B. Crowder. University of Wisconsin - Madison and North Carolina State University -- *A stage-based population model for loggerhead sea turtles and implications for conservation*.

Management of many species is currently based on an inadequate understanding of their population dynamics. Lack of age-specific demographic information, particularly for long-lived iteroparous species, has impeded development of useful models for a number of species. We use a Lefkovitch stage-class matrix model, based on a preliminary life table developed by Frazer (1983), to point to interim management measures and to identify those data most critical to refining our knowledge about threatened loggerhead sea turtles (*Caretta caretta*). Population projections are used to test variance in parameter estimates as well as the likely response of the population to various management alternatives. Current management practices may be focused on the least responsive life-stage, eggs on nesting beaches, while alternative protection efforts for juvenile loggerheads may be far more effective.

55

HEPP, GARY R., DONNA J. STANGOHR, LESLIE A. BAKER, and ROBERT A. KENNAMER. Savannah River Ecology Laboratory--*Variation in the egg and duckling components of Wood Ducks.*

We collected 3 eggs from each of 35 female Wood Ducks (*Aix sponsa*). Fresh egg mass averaged 44.2 g and consisted of 53.1% albumen, 36.4% yolk, and 9.6% shell. All egg components except dry albumen increased in direct proportion to fresh egg mass. Variation among females explained 52% to 80% of the total variation in mass and composition of eggs. Body mass of hens during incubation was correlated with estimates of pre egglaying lipid reserves (r_s=0.66), therefore, body mass was a good measure of female quality. Body mass was independent of age and structural size, and was positively related to mean egg mass, egg components, energy density of eggs (kJ/g), and clutch mass, but not to clutch size or time of nesting. Female body mass explained more variation in albumen components than in yolk or shell components. Pre breeding condition of female Wood Ducks is important because it allows hens to accumulate exogenous protein for egg synthesis. Data do not support predictions based on optimal egg size theory. Body mass of ducklings averaged 23.7 g (*n* 13). Ducklings contained 65.9% water and 32.5% lipids (dry mass). Components of ducklings increased in direct proportion to fresh egg mass, however, egg mass was a poor predictor of duckling lipid content.

56

SMITH, EMLYN B. and WINSTON P. SMITH. Southeastern Louisiana University and Tennessee Technological University--Nest site characteristics of the Mississippi sandhill crane (Grus canadensis pulla) on the Mississippi Sandhill Crane National Wildlife Refuge.

In 1983 and 1984 nesting platforms of the Mississippi sandhill crane and systematically selected sites (random sites) were sampled intensively during the period of nest site selection (March-April) and during May - June (post hatching. Multivariate analyses facilitated the discrimination of nest sites from the remainder of the available habitat during both sampling periods. Water depth and ground cover of water around the nest site differed from random sites during the post nesting 1983 period and prenesting 1984. The presence of water around the nest site was later reflected as bare ground during post nesting 1984, and absence of vegetation during all sampling periods. Surface invertebrates were more abundant and diverse at nest sites compared to random sites. The presence of water around the nest site may play an important role in restricting the surface invertebrates to upright vegetation, allowing them to be caught more easily by both the chicks and adult cranes. Water around the nest site may also offer protection from predators to the nesting cranes. When water was not available around the nest site the results from the discriminant model showed the density of vegetation was significant.

57

FLEMING, THOMAS V. and RONALD D. GETTINGER. University of Alabama at Birmingham-- Dynamics of an Alabama old field rodent community.

Available information concerning the population ecology of rodent species in Alabama is currently not extensive. As part of an investigation of seasonal reproduction and thermoregulation, we have undertaken a mark/release study to provide such population data for several species. A permanent 10 x 10m trapping grid was established in old field habitat in St. Clair County, Alabama. Each month, beginning in June, 1986, small mammal abundance has been assessed in this grid and in trapping transects set in nearby fields. Four rodent species (eastern harvest mouse, Reithrodontomys humulis ; pine vole, Microtus pinetorum ; cotton rat, Sigmodon hispidus ; and house mouse, Mus musculus) and one species of shrew (Cryptotis parva) have been captured. Pine voles and harvest mice are most frequently captured. Preliminary estimates indicate that pine vole abundance has steadily increased. Conservative estimates of density in November, 1986, approach peak densities reported for voles in apple orchards, previously considered as prime vole habitat. During the same period, harvest mouse abundance has been relatively stable, but appears to have declined since trapping in May, 1986, before establishment of the permanent grid. Subtle changes in habitat structure associated with succession may account for the abundance patterns observed thus far. However, with no experimental evidence to the contrary, direct competition between the species cannot be ruled out.

58

HARVEY, MICHAEL J. Tennessee Technological University--Population decline of the endangered Indiana bat, Myotis sodalis, in Tennessee and Arkansas.

Only thirteen Tennessee caves and six Arkansas caves are currently known to serve as hibernacula for colonies of Indiana bats. Several caves known to house hibernating colonies of Indiana bats in the past are no longer inhabited by the species. The Tennessee population numbers ca. 22,170 and has decreased during recent years. The Arkansas population numbers ca. 2,630 and has declined over 50% during the last five years. Indiana bat populations continue to decline throughout the range of the species.

59

PEARSON, SCOTT M. University of Georgia--Interspecific dynamics of wintertime mixed-species bird flocks.

A field experiment was conducted during the winters of 1985-86 and 1986-87 to investigate the intraspecific and interspecific interactions within wintertime bird flocks. At each field site, three feeding stations were established with different food dispersions. Food dispersion, on ground and elevated feeders, was used in attempt to control flock composition. Species presence and numbers were recorded for each feeding station at 2 minute intervals during each observation session. In addition, transect censuses were performed during the 1987 field season to compare flock characteristics observed at the feeding stations with those in more natural situations. Data was analysed to investigate the effects of individual species on flock size and composition. Certain species were found to facilitate flocking while others showed little or no effect. Findings also suggest that members of the bark-foraging and graminivorous guilds of birds will associate during feeding given the opportunity of adequate food levels and a common habitat.

60

BERGSTROM, BRADLEY J. Valdosta State College--Aggression, parasites, and parapatry in chipmunks.

In the Front Range of northern Colorado, Tamias quadrivittatus inhabits the lower montane life zones up to about 2130 m elevation, where it is parapatric with T. umbrinus, which inhabits the upper montane region up to treeline. A third, smaller species, T. minimus, is sympatric with both of its congeners over the entire elevational range. A concurrent study indicated that the two parapatric species were very similar in structural habitat selection and behavioral niche components, especially compared to T. minimus. Interspecific territories were defended by each of the solitary species; aggressive dominance was largely determined by ownership (the "Bourgeois" strategy). In feeding station encounters staged in the zone of parapatry, however, T. umbrinus was more aggressive, overall, than its congeners and directed more interspecific aggression toward its more similar congener, T. quadrivittatus. Data from four seasons suggest that T. umbrinus at the lower elevation of its range is more susceptible to subcutaneous myiatic infestation by larval bot flies (Cuterebra fontinella) than is T. quadrivittatus. The usually non-lethal infestations are known to diminish activity levels in chipmunk hosts. Since the bots occur only below 2200 m, the very predictable elevation of parapatry may be explained as a balance of aggressive dominance between infested and uninfested populations of the two host species.

61

COLIN, GERMAINE, C. B. COBURN. Tennessee Technological University---Migration of Peromyscus leucopus along Interstate right-of-way.

The objective of this research was to determine whether the 23.6 meters of mowed grass, paved shoulders and highway surface was a barrier to Peromyscus leucopus movement. In a total of 11,800 trap nights in the summer of 1985 along Interstate 40, Putnam County, Tennessee, 17 individuals were captured, marked, and released. The recapture rate was 70.6%. Seventy two percent of the mice recaptured moved toward the highway and 18% moved away from the highway. Fifty eight percent of the recaptures had crossed at least one lane of the highway. Three mice crossed all lanes. One mouse crossed all lanes and returned across all lanes to its original trap site.

62

BARRY, RONALD E., JR. and ALAN A. HEFT. Frostburg State College--Three's company in a western Maryland woodlot.

Three rodents - Peromyscus leucopus (the white-footed mouse), P. maniculatus (the deer mouse), and Clethrionomys gapperi (the red-backed vole) - coexist in a rocky, western Maryland deciduous woodlot at 600 m elevation. A two-year live-trapping study on a one-hectare wooded plot with 76% rock cover was conducted to determine the dynamics of spatial relationships among these mammals. Persistent negative spatial associations at ground level, negative correlations of capture frequencies at trap stations, and little interspecific overlap of home ranges between the two Peromsycus, except at very high population densities, were consistent with differences in microhabitat affinities between these two species. Generally, significant spatial associations did not exist between the red-backed vole and either species of Peromyscus. However, positive correlations existed between capture frequencies of the red-backed vole and the deer mouse at trap stations in the study plot, and both species shared a statistically significant preference for microsites with abundant rock cover. The relative capture frequency of deer mice in elevated traps in stems exceeded that of white-footed mice and that of deer mice in ground-based traps. Red-backed voles were less abundant and less vagile than either Peromsycus and never climbed. It appears that differences among these three potentially competitive mammals in microhabitat affinities and surface and arboreal activity, and the abundance of ground refuges in their rocky habitat, permit their coexistence.

63

BRISBIN, I.L., and E.L. PETERS. Savannah River Ecology Laboratory--Field Studies of Contaminant Uptake by Organisms in Aquatic and Terrestrial Environments.

Current ecological theorey holds that the uptake of environmental contaminants by free-living organisms follows a negative exponential or monomollecular asymptotic function. Times required to approach equilibrium levels of body burden are also assumed to be predictable from laboratory-determined turnover rates or half-lives. However, our field studies of feral bantam chickens (Gallus feralensis) in a bottomland swamp-forest floodplain and slider turtles (Pseudemmys scripta) in a former reactor cooling reservoir, suggest that contaminant uptake patterns may actually be sigmoidal in shape, with an initial lag phase that may be related to behavioral factors. These factors may apply to a broad array of organisms in a broad array of habitat types. Times required to reach equilibrium levels of body burdens may thus be significantly underestimated by calculations based upon laboratory turnover rates alone.

64

SCOTT, DAVID E., and J. W. GIBBONS. Savannah River Ecology Laboratory--Intraspecific density effects on larval Ambystoma opacum body size and survival in large-scale field enclosures.

Amphibians exhibit complex life cycles, and factors which affect larval success may ultimately influence parameters related to adult fitness. We examined intraspecific density effects on larval survival, body size at metamorphosis, and total lipids in the marble salamander, Ambystoma opacum. Larval densities were manipulated in six field enclosures, each approximately 30 m^2, which ensured natural conditions (i.e. complex physical habitat structure, a full complement of prey species, and minimal "enclosure effect"). The two levels of density used, 10 larvae/m^2 and 43/m^2, were within the range of naturally occurring densities. Larvae in high density enclosures exhibited smaller body size at metamorphosis, lower total lipid stores, and greater mortality. In a study of a closely related species, Ambystoma talpoideum, it was found that juvenile body size is positively related to adult body size, and presumably adult reproductive success. In larval A. opacum, intraspecific competition may cause reduced body size at high densities, and consequently lower adult reproductive potential. Additional population regulation may result from larval density-dependent mortality.

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D.R. Varney[1], H.C. Hem-Lee[1], C.J. Kappes[1], R.S. Newsome[1], S.L. Jones[1], M.R. Siegel[2] and P.M. Zavos[2]. Eastern Kentucky University[1] and University of Kentucky[2]. Physiological effects of tall fescue toxicity on rat visceral organs and glands.

Forty-nine Sprague-Dawley female rats (125 g) were maintained on dietary treatments (for 70 days) as follows: (I) 100% rodent chow; (II) same as I, but restricted to intake of VII; (III) a mixture of 50% chow (w/w) and 50% endophyte-free KY-31 tall fescue seed; (IV) same as III, but restricted to intake of V; (V) a mixture of 50% chow, 25% endophyte-free and 25% endophyte-infected (Acremonium coenophialum) tall fescue seed; (VI) a mixture of 50% chow, 12.5% endophyte-free and 37.5% endophyte infected-tall fescue seed; and (VII) a mixture of 50% chow and 50% endophyte-infected tall fescue seed. Daily feed consumption and body weights were measured throughout the study. Tissues assessed were brain, pituitary, thymus, thyroid, adrenal, gall bladder, lung, liver, pancreas, spleen, ovary, uterus, heart and stomach. Data were analysed using General Linear Models procedure from Statistical Analysis Systems. Significant differences ($P<0.05$) were obtained for pituitary, thymus, liver, pancreas, ovary, uterus and heart.

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D.R. Varney[1], C.J. Kappes[1], S.L. Jones[1], R.S. Newsome[1], M.R. Siegel[2] and P.M. Zavos[2]. Eastern Kentucky University[1] and University of Kentucky[2]. The effect of feeding tall fescue seed infected by Acremonium coenophialum on pregnancy and parturition in female rats.

Forty-nine Sprague-Dawley female rat (ca. 125 g) were randomly assigned to dietary treatments containing: (I) 100% Purina rodent chow, ad libitum; (II) same as I, but restricted to daily intake of VII; (III) a mixture of 50% rodent chow (w/w) and 50% endophyte-free tall fescue (Festuca arundinacea) seed; (IV) same as III, but restricted to daily intake of V; (V) a mixture of 50% rodent chow, 25% endophyte-free tall fescue seed and 25% endophyte-infected (Acremonium coenophialum) tall fescue seed; (VI) a mixture of 50% rodent chow, 12.5% endophyte-free and 37.5% endophyte-infected tall fescue seed; and VII a mixture of 50% rodent chow and 50% endophyte-infected tall fescue seed. Females were preconditioned on their respective diets for 21 days, after which time a different male of the same age was placed with each female for 10 consecutive days. The females were maintained on their diets through weaning of the pups. Parameters assessed were: average daily intake (ADI) and weight gain (ADG) during preconditioning and during pregnancy, % litter production, % pregnancy (examination of uteri for uterine scars), litter weight, number of pups per litter and weight per pup. The results showed reduced ($P<0.05$) ADI and ADG for the Diet VII animals and similar trends in other treatments. Only the Diet VII animals showed significant reduction ($P<0.05$) in pregnancy and litter production. The litter weights and weight per pup per litter indicate trends for lower measurements associated with higher concentrations of infected seed in the diet.

67

ROBERT U. FISCHER, JUSTIN D. CONGDON, FRANK J. MAZZOTI AND ROBERT E. GATTEN, JR. Savannah River Ecology Laboratory, Pennsylvania State University and North Carolina State University at Greensboro -- Developmental energetics of American alligators

Eggs of American alligators Alligator mississippiensis were collected in Louisiana during the nesting season of 1986. Clutches of eggs were randomly assigned into one sample that was immediately extracted with petroleum ether for total lipids. A second sample of eggs was incubated at 30.5 C and 33.5 C. Hatchlings from these eggs were separated into bodies and yolk sacks and total lipids from each compartment were extracted as above. Total wet mass of eggs averaged 74.1 g and dry mass averaged 24.9 g. Eggs were composed of 66% water, 13% lipid, and 21% lean dry matter. Hatchlings averaged 53.1 g total wet mass and 14.21 g total dry mass. Total hatchling mass averaged 73% water, 11% lipids and 16% lean dry material. Total dry mass of material converted from egg to hatchling averaged 84% and lipid mass converted averaged 77%. Hatchlings from each incubation temperature had similar amounts of total lipids, however the compartmentalization of the lipids differed.

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CONGDON, JUSTIN, D. AND ROBERT E. GATTEN, JR. Savannah River Ecology Laboratory and North Carolina at Greensboro -- Use of anaerobic metabolism to support nesting of painted turtles.

Many reptiles utilize anaerobic glycolysis to support short-term vigorous behaviors or aquatic hibernation. Information on nesting migrations and nest construction indicate that these behaviors combined may be the most strenuous and long duration activities that are routinely engaged in by freshwater turtles. To determine whether painted turtles (Chrysemys picta) use anaerobic metabolism to fuel nesting we made the following observations. From 1983 through 1986 nesting migrations and nesting behavior of painted turtles were observed on the University of Michigan's, E. S. George Reserve in southeastern Michigan. During 1985 and 1986, female painted turtles were observed, collected as they completed nesting, and then their whole body lactate levels determined. The majority of nesting migrations were completed on the same day, although some took as long as six days. Gravid females averaged 3.2 hours to move to nest sites and 1.0 hours to return. The time from initiation of nesting to leaving the nest site averaged 1.44 hours (N = 86). Whole body lactate of females at the termination of nesting averaged 6050 (mg x g - 1;± = 1270).

69

CLAIBORNE, JAMES B. and DAVID H. EVANS. Georgia Southern College, and University of Florida—Acid-base effects and ammonia transfers during exposure to high ambient ammonia in a marine fish.

In ammonotelic teleost fish, nitrogenous wastes are excreted across the gills as ammonia (in two forms : NH_3 and NH_4^+). While both forms may passively diffuse from the animal to the water, evidence for the active exchange of internal NH_4^+ for external Na^+ or H^+ has been described in some freshwater species. Since these ion exchange mechanisms were elicited by high external ammonia concentrations, we tested for their occurrence in a marine teleost, the long-horned sculpin (Myoxocephalus octodecimspinosus), by exposing fish to seawater in which the total ammonia ($T_{AMM} = NH_3 + NH_4^+$) had been increased. Plasma pH and T_{AMM}, as well as net ammonia (ΔNH_4^+), bicarbonate (ΔHCO_3^-), and acid (ΔH^+) transfers, were monitored during control (2-3 hours), high external ammonia (HEA; 6 hours), and recovery periods (15 hours). While plasma pH was not changed during HEA exposure, plasma T_{AMM} had increased from a control of 230 to 839 uM at hour 6 (but remained below that of the water: 1175 uM). A control ΔNH_4^+ efflux (.271 $mMole \cdot kg^{-1} \cdot h^{-1}$) was reversed to an influx (-1.216) after 1 hour and then returned to an efflux once again (0.442 by hour 6). Ammonia transfers accounted for 90% of the ΔH^+ during the HEA. A positive (from fish to water) control NH_3 diffusion gradient of about 60 uTorr was decreased to zero during the HEA, and then was restored during the recovery period. These results may suggest that a majority of the ammonia entered the animal as NH_4^+ during HEA and that the sculpin is capable of actively extruding ammonia under these extreme conditions. Funded by a grant from GSC to JBC and NSF PCM 83-0261 to DHE.

70

Zavos, Panayiotis M. University of Kentucky and Andrology Institute of Lexington—Comparative measurements of equine spermatozoa concentration between the hemacytometer, spectrophotometer and the Makler chamber method.

The objective of the present study was to assess the accuracy and applicability of the Makler chamber method when compared to two other well adopted methods (hemacytometer and spectrophotometer) for counting equine spermatozoa. Fifteen ejaculates were collected via an artificial vagina from fifteen different stallions of known fertility. Specimens were counted in the undiluted form or diluted 1:1, 1:5, 1:10 and 1:20 using the Makler method, diluted 1:100 and 1:200 using the hemacytometer method and 1:20 using the spectrophotometer (Spec-20) method. In all instances, two different readings were taken from each preparation within each method by the same observer and averaged to provide the final count obtained. The results obtained in this study showed that the Makler method was far superior ($P<0.05$) to the Spec-20 method. The mean deviation between the Makler (1:5 dilution) and Spec-20 methods was 17.8%, where the deviation between the Makler (1:5 dilution) and hemacytometer methods was only 3.2%. The results of the present study are in agreement with data generated by others utilizing the Makler method in counting human, bovine and ovine spermatozoa. The Makler method as applied in this study, showed a great deal of promise and was quite superior ($P<0.05$) to the most conventional method for counting equine spermatozoa today, i.e. the Spec-20. Also, the Makler method had the advantage of giving the examiner not only an accurate assessment of the sperm concentration, but an immediate impression of the observed specimen as well.

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Zavos, Panayiotis M., Burhanuddin Salim and Bradley Neil. University of Kentucky—Libido scores and daily sperm production potential (DSP) in bulls fed different energy level rations.

The objective of this study was to assess the effects of two different energy level rations on the reproductive behavior and daily sperm production potential (DSP) in bulls. The animals used in the study were 20 Angus bulls which were randomly allocated into two groups (age = 239.6$\pm$17.2 days). Animals in Group 1 were fed a high energy level ration where animals in Group 2 were fed a low energy ration formulated to provide, ad libitum, approximately 75% of the total energy intake of bulls in Group 1. Growth and libido measurements were taken every 4 weeks for the duration of 30 weeks. DSP measurements were assessed on excised testes taken at slaughter at termination of the experiment (30-week period). Bulls fed the high energy diet showed lower libido scores ($P<0.01$) and spermatogenic capacity assessed via the DSP (4.63 vs 5.15 x 10^9 spermatozoa per bull; $P<0.01$) than bulls fed the lower energy diet. The results suggest that excessive energy intake by bulls during their early sexual development could have detrimental effects upon their reproductive behavior (libido) and ability of the testes to produce spermatozoa as shown by the DSP measurements.

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TURNER, LISA D., J. F. MCFADDEN, and E. L. MORGAN. Tennessee Technological University--Correlating oxygen consumption and breathing rates of bluegill (Lepomis macrohirus) using a computer monitored fish respiration chamber.

The objective of this research was to develop a fish respiration model derived from breathing and oxygen consumption rates. In meeting this objective, a computer-monitored automated fish breathing rate device was coupled with an oxygen consumption chamber. This system continuously recorded breathing events and oxygen consumption rates. Correlations developed between oxygen consumption and breathing rates provided a direct approach for estimating metabolic demands from breathing data alone. In the laboratory bluegill (Lepomis macrohirus) of different weights under a controlled temperature were used to find a correlation between oxygen consumption and breathing rate. This correlation served as a model of mass of oxygen consumed against breathing events. An R^2 value of .98 was developed for this relationship.

73

MORTON, DAVID and DWAYNE SHUHART Frostburg State College--Determination and estimation of total body iron in Peromyscus.

Total body iron (TBI) was measured by a wet ash technique in 7 Peromyscus maniculatus and 17 Peromyscus leucopus. As there were no significant differences between species or sex, the data was pooled. TBI was 1.59 $\pm$ 0.44 mg (mean $\pm$ standard deviation) for mice with a mean mass of 20.6 $\pm$ 3.5 g or 77.8 $\pm$ 18.2 mg/kg body mass. Values ranged from 48.9 to 108.2 mg/kg body mass. There was a significant linear relationship between TBI (mg Fe) and body mass (g) ($y = 0.32 + 0.06x$; $R = 0.49$). In 13 mice, chemically measured spleen and liver iron, histochemically graded bone marrow, spleen and liver iron, and hematocrit were investigated as estimators of TBI. Histochemically graded iron was the only variable significantly correlated with TBI (mg or mg/kg body mass) ($R_s = 0.71$;

R_s = 0.88, respectively). Pregnancy and parasitism by *Cuterebra* larva decrease the amount of stainable iron in the spleen. This is apparently due to loss of iron stores to the fetuses or parasite and to an increase in spleen size, especially in parasitized mice.

74

HOGAN, G.R. East Texas State University *Temporal and Spatial Leukocyte Patterns Following Cadmium Treatment*.

Cadmium is a well known environmental toxicant affecting a variety of systems. One such system is the hemopoietic one where cadmium has been shown to influence both erythrocytes and leukocytes (wbc). The studies presented here explore further the effects on wbc. The time course of a cadmium-induced leukocytosis in female mice is reported. In addition, changes in the numbers of peripheral lymphocytes and neutrophils are correlated with the temporal shifts in the total number of wbc. Data indicate a dramatic increase in the total wbc counts in cadmium-treated mice on days 3,5, and 7; the effect appears to begin, however, on day 1 post-cadmium. The major leukocyte shift on day 3 is associated with elevated neutrophil counts, while on day 5 the total wbc increase is due primarily to a marked lymphocytosis. Dose-response data suggest a threshold for the wbc effects of 2.0 mg/kg cadmium chloride.

75

ROSS, STEVE W., FRED C. ROHDE, and DAVID G. LINDQUIST. North Carolina State University, North Carolina Division of Marine Fisheries, and University of North Carolina-Wilmington--*An evaluation of the endangered, threatened, and vulnerable marine fishes of North Carolina.*

The 1977 list of endangered, threatened, and otherwise vulnerable marine fishes of North Carolina was reevaluated and updated. Criteria for inclusion on the current list included: 1)federally-listed species, 2) fishes rare throughout their range, and 3) fishes strongly tied to vulnerable habitats in addition to having low or widely varying abundance. We listed seven fishes for North Carolina. The shortnose sturgeon, *Acipenser brevirostrum*, is a federally-listed endangered fish. The other six are considered vulnerable: Atlantic sturgeon, *Acipenser oxyrhynchus*; opossum pipefish, *Oostethus brachyurus*; freckled blenny, *Hypsoblennius ionthas*; spinycheek sleeper, *Eleotris pisonis*; lyre goby, *Evorthodus lyricus*; and marked goby, *Gobionellus stigmaticus*. Because of apparently declining population sizes perhaps due to heavy fishing pressure and reduced spawning areas, four anadromous fishes are of concern: blueback herring, *Alosa aestivalis*; alewife, *A. pseudoharengus*; American shad, *A. sapidissima*; and striped bass, *Morone saxatilis*. Increased sampling in certain habitats which yielded improved distribution and abundance data resulted in the delisting of five fishes from the 1977 list: marsh killifish, *Fundulus confluentus*; spotfin killifish, *F. luciae*; seaweed blenny, *Blennius marmoreus*; crested blenny, *Hypleurochilus geminatus*; and fat sleeper, *Dormitator maculatus*.

76

LINDQUIST, DAVID G. and PATRICIA BERNIER McNEESE. University of North Carolina at Wilmington--*Status and biology of the North Carolina population of the freckled blenny, Hypsoblennius ionthas*.

North Carolina's population of the freckled blenny is the northernmost extent of the species which ranges south to Matanzas Inlet, Florida, and along the northern Gulf of Mexico coast from Cedar Keys, Florida, to Aransas Bay, Texas. The species appears to be uncommon to rare in the South Atlantic Bight region. The North Carolina distribution of **H. ionthas** is primarily limited to the lower Cape Fear River estuary (single specimens have been taken recently from the New and Shallotte River estuaries). Data from Carolina Power and Light Company's Brunswick Steam Electric Plant (BSEP) biological monitoring reports suggest a more abundant population of **H. ionthas** existed in the lower Cape Fear River estuary during the middle 1970s and has since decreased in abundance. This population has been subject to impingement mortality on the BSEP traveling intake screens. Recent improvements have been made to increase impingement survival of fish through a sluiceway return to the estuary (the effect on **H. ionthas**, if any, is unknown). Salinity data from captured specimens suggests that **H. ionthas** occurs frequently at lower salinities (0 - 15 ppt). Trophic ecology and morphology indicate grazing or picking of small crustacea and associated encrusting organisms. Examination of gonads suggests spawning occurs from early spring to late summer.

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ROHDE, FRED C. and STEVE W. ROSS. North Carolina Division of Marine Fisheries and North Carolina State University--*The gobioid fishes of North Carolina.*

A total of 23 species of gobioid fishes in three families (Eleotridae, Gobiidae, Microdesmidae) occurs in North Carolina waters and this number is substantially more than reported in the literature. Eleven species (47.8%) are mostly restricted to the estuaries in a variety of habitats: *Dormitator maculatus* (common-low salinty, shallow marshes), *Eleotris pisonis* (rare-low to high salinity marshes), *Bathygobius soporator* (rare-muddy bottoms), *Evorthodus lyricus* (rare-low to high salinity, shallow marshes), Gobionellus boleosoma (common-high salinity marshes), G. hastatus (common-high salinity creeks and bays, mud bottoms), G. shufeldti (common-low salinity to freshwater creeks), G. stigmaticus (rare-high salinity, sand/shell bottom), Gobiosoma bosci (abundant-shallow, muddy creeks and bays, low to medium salinity), Microgobius thalassinus (abundant-same as G. bosci), and Microdesmus longipinnis (rare-mud/clay bottom). Nine species (39.1%) occur only on or near offshore reefs in depths greater than 15 m: Coryphopterus glaucofraenum, G. punctipectophorus, Evermannichthys spongicola, Gnatholepis thompsoni, Gobiosoma xanthiprora, Ioglossus calliurus, Lythrypnus phorellus, L. spilus, and Quisquilius hipoliti. Gobionellus saepepallens and Microgobius carri occur in offshore waters on sand/shell bottoms. Gobiosoma ginsburgi is found both in estuaries and offshore reefs usually on shell. The offshore gobies are generally subtropical/tropical reef-oriented species while the inshore estuarine gobioid fauna is most similar to the warm temperate northern Gulf of Mexico.

78

POWELL, AMY and GARY K. MEFFE. Savannah River Ecology Laboratory--Life history patterns of mosquitofish (Gambusia affinis) in thermal and ambient environments.

Studies of thermally stressed ecosystems have demonstrated profound effects of elevated temperature on community attributes such as species diversity, biomass, and equitability. More detailed information regarding impacts of heated effluents on life histories of aquatic species would begin to address the possibility of short-term evolutionary change imposed by thermal stress. Such changes would in turn affect community structure. Consequently, we compared reproductive patterns of mosquitofish from both ambient and thermally stressed habitats on the Savannah River Plant in South Carolina. Somatic and reproductive data were analyzed from monthly samples at each location. The two populations were significantly different in several parameters, including annual reproductive cycle, fecundity, and somatic condition. Other studies have demonstrated differences in genetic variation between mosquitofish populations from thermal and ambient habitats, implying a genetic basis for life history differences. Further research should emphasize genetic versus environmental components of life history differences in these populations to determine if thermal stress has resulted in evolutionary change of life history characters.

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DOHERTY, TERESA A. University Of Southern Mississippi--Changes in the feeding behavior of the blacktail shiner, Notropis venustus, in relation to the threat of predation.

The blacktail shiner is commonly found in schools of similarly-sized individuals. Such schools may function to increase the efficiency of finding food or decrease the risk of predation on any one individual. I examined feeding and resting (non-feeding) behavior in four different group sizes (N = 2, 3, 4 and 8) of shiners in the absence and presence of a predator. I hypothesized that fish in the larger group size would feed more actively in the presence of a predator because the perceived threat per individual would be lower. Data collected in the absence of a predator indicated that groups fed differently (i.e., at different rates and from different positions in the water column). Groups also used the water column differently during rest. In the presence of a predator, resting behavior in the groups tended to converge; the fish formed a tight group in the lower portion of the tanks. Feeding experiment results are more ambiguous. Preliminary data indicate that the degree of group response is, in part, related to the predator's position in the water column. Differential feeding responses of fishes to predator and predator-free situations are discussed in light of current theories suggesting subjugation of predation-risk to food intake.

80

PETERSON, MARK S., STEPHEN T. ROSS AND DANIEL E. GUSTAFSON. University of Southern Mississippi--Morphometric and Meristic Characteristics of a Peripheral Population of Enneacanthus.

Bluespotted sunfish, Enneacanthus gloriosus (Holbrook), are known to inhabit acidic, black water streams from New York through Bluff Creek, a tributary of the Pascagoula River, Mississippi. Enneacanthus gloriosus and E. obesus (Girard) are sympatric and exhibit the same diel activity and reproductive periods. The species have been shown to hybridize in New Jersey and Connecticut, with hybrids having significantly different intermediate values for selected morphometric and meristic characters. Additionally, hybridization may explain the confusing intermediacy of characters noticed in some specimens from Gulf of Mexico drainages. A series of specimens from Florida, Alabama and Bluff Creek indicate clinal variation in head and orbit dimensions. Thus, fish from western, peripheral populations need further study. We examined an Enneacanthus population from Old Fort Bayou, using a suite of 18 morphometric and meristic characters. In addition, we examined material of E. gloriosus and E. obesus from Maryland, South Carolina and Florida. Principal components analysis and ANOVA indicate that the circumferential scale row count and associated vertical bars separate the species. We refer this westernmost population of Enneacanthus to E. gloriosus based upon its closer meristic affinity to other E. gloriosus populations. However, E. gloriosus from Old Fort Bayou have significantly lower scale counts than either E. gloriosus or E. obesus. Scatterplots of the opercular spot diameter vs SL not only separates both species but also suggests that Old Fort Bayou Enneacanthus have a smaller spot than other Enneacanthus.

81

ETNIER, DAVID A. University of Tennessee --Characters and distribution of *Etheostoma duryi* and the undescribed golden darter.

Etheostoma duryi differs from the closely related golden darter in having a total of 26 or more dorsal saddles and lateral blotches (both sides) vs. 25 or fewer, modally 12 soft dorsal fin rays (except well upstream from area of parapatry) vs. modally 11, and in having a red (cream in preservative) ocellus in the first spinous dorsal fin membrane in over 50% of adults vs. in 25% or fewer of adults in the golden darter. Live and freshly preserved specimens of the taxa differ in color--*duryi* has gray or green lips and an orange spot above and below the basicaudal dark spot; golden darters have orange lips and lack basicaudal orange spots. Golden darters occur in the Cumberland River drainage from Harpeth River downstream, in eastern tributaries to the Tennessee River below Duck River, in Buffalo River, and in most of Duck River and Indian Creek; while *duryi* is essentially parapatric, in the remainder of the Tennessee drainage upstream through lower Clinch River and downstream nearly to Kentucky, and in upper Duck River and lower Indian Creek. Introgressive hybridization has apparently occurred in the few areas of sympatry, with golden darters swamping *duryi* in chert gravel streams of the Highland Rim, and *duryi* swamping goldens over darker limestone substrates.

82

SHUTE, JOHN R. and PEGGY W. SHUTE. University of Tennessee--Laboratory rearing of endangered and threatened madtoms, *Noturus baileyi* and *N. flavipinnis*.

A part of the management plans for the smoky madtom, *Noturus baileyi* (endangered) and yellowfin madtom, *N. flavipinnis* (threatened) includes reintroduction of both species into suitable habitat within their historic range. In an attempt to do this, eggs and larvae of both species were collected during June 1986 from Citico Creek (Little Tennessee system) and transported to rearing chambers in the lab. Approximate numbers of eggs and larvae of *N. baileyi* and *N. flavipinnis* removed from Citico Creek are 300 (12 nests) and 250-275 (4 nests), respectively. Initially, an attempt was made to collect eggs that were well-advanced developmentally. However, it was discovered that while eggs were more easily transported than larvae, larvae were more resistant to fungal outbreaks once in the lab. Therefore, subsequent collections concentrated on larvae. Initial mortality was low, and approximately 200 of each species were reared to juvenile stages (yolk absorbed). However, one month later it was necessary to move aquaria and apparently an unidentified toxin resulted in the loss of all of the smoky madtom and the majority of yellowfin madtom juveniles. On October 1, 1986, after receiving permission from National Park Service, 18 *N. flavipinnis* (approx. 25-35 mm TL) were released into Abrams Creek (Little Tennessee system). The success of this introduction is undetermined at present. Future plans include monitoring of this introduced population plus further attempts at lab rearing of both species for further reintroductions.

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AHO, JOHN M., ROBERT U. FISCHER, JUSTIN D. CONGDON, AND CHRISTINE DeFONZIO. Savannah River Ecology Laboratory--Lipid and reproductive cycles in bluegill, *Lepomis macrochirus*, in nuclear reactor cooling reservoirs.

In two thermally influenced reservoirs on the Savannah River Plant, Aiken, SC, lipid and reproductive cycling has been examined in bluegills, *Lepomis macrochirus*, to determine how resource harvesting patterns are modified by environmental stressors. Comparative material was collected from three locations during 1986 representing high, moderate, and ambient water temperatures, with the reproductive condition of each adult recorded and lipids extracted from fat bodies, liver, gonads, and carcass using petroleum ether and a Soxhlet apparatus. Seasonally, total lipid concentrations varied regardless of sample site, sex, or age class, but the peaks were not coincident. For the different sites of lipid compartmentalization, only the liver did not exhibit temporal variation. Short-term responses for lipid cycling in the high water temperature location, where fish are usually confined to small coolwater refuge areas during periods of reactor operation, were dramatic. During one reactor cycle (hot/ambient/hot), total lipid concentrations did not change appreciably during the first 14 days of the shutdown, and then increased at a rate ca. 3% of body weight per week for both adult and juvenile fish. Fat body deposition, and later gonad development, commenced when body concentrations approached 25% of body weight suggesting a threshold value exists to initiate reproduction. The pattern of lipid deposition parallels the establishment of a forage base within the main lake and a lag in its development.

84

SUTTKUS, ROYAL D. and GERALD E. GUNNING. TULANE UNIVERSITY--Fishes of the lower Mississippi River.

Our current fish sampling efforts continue at two sites, one at Fort Jackson, River Mile 20, and the other at English Turn Bend, River Mile 78. Thirty nine species have been taken at Fort Jackson and of these 25 (64%) are marine invaders. Seventy eight species have been collected at English Turn Bend and of these 15 (19%) are marine invaders. The seasonal presence of the saltwater wedge undoubtedly promotes the invasion of marine fishes.

85

FACEY, DOUGLAS E., GARY D. GROSSMAN, and GENE S. HELFMAN. University of Georgia--Is the cost of holding position important in microhabitat selection by stream fishes?

Community ecologists are interested in the mechanisms that determine resource use by different species. We compared observed focal point velocities of four stream fishes to available velocities during five seasons, and considered the results relative to estimates of the energetic cost of holding position. Rosyside dace were over-represented at low velocities in four of five seasons, suggesting that this species may minimize energetic expense by avoiding more costly velocities. This was not true for rainbow trout, which showed no preference for lower velocities in four of five seasons. Mottled sculpin were consistently over-represented at velocities near 0 body lengths per second, though oxygen consumption data suggested no energetic advantage to these low velocities. The distribution of longnose dace was not significantly different than the distribution of available velocities; longnose dace also showed no difference in oxygen consumption across these velocities. Microhabitat selection by rosyside dace and longnose dace was generally consistent with an energetic explanation, whereas other factors such as cover or food availability are apparently more important to rainbow trout and mottled sculpin.

86

HAINES, A.G., and V. BRACK, JR.,. WAPORA, Inc.--Fish species richness in relation to stream order in coastal plain streams of Delaware.

Detailed distribution data on Delaware coastal plain fishes was lacking prior to a baseline study conducted during spring 1985. Fish were sampled by seining at 78 stations distributed among order one through order four streams located on the Delmarva Peninsula, Delaware. A total of 41 species were collected, within 18 families, including freshwater and estuarine inhabitants. The most common species found in all stream orders were: Anguilla rostrata, Esox americanus, Notemigonus crysoleucas, Erimyzon oblongus, Ictalurus nebulosus, Fundulus diaphanus, Morone americana, Lepomis gibbosus, Lepomis macrochirus, Micropterus salmoides, and Etheostoma olmstedi. Streams sampled ranged from non-tidal freshwater to tidal estuarine, but were predominantly freshwater. Species richness increased as stream order increased, but varied within streams of an order because of differences in habitat, water quality, and tidal influences. The number of species ranged from 14 in order one streams to 28 in order four streams. Increases in richness between stream orders was related to habitat diversity and stream size.

87

Maurakis, E. G.,[1] and J. B. Kahnke,[2] The George Washington University[1] and George Mason University[2].--Construction of spawning nests by two recently described or redescribed chub species from southeastern United States (Pisces: Cyprinidae).

Semotilus thoreauianus(Jordan) and Campostoma pauciradii (Burr and Cashner) are identified as two additional cyprinid species that build gravel nests for spawning. Five spawning nests of S. thoreauianus were located in first order tributaries of the North Oconee River in the Altamaha River drainage in northeastern Georgia in mid April at water temperatures of 16 to 17 C. Semotilus thoreauianus constructs pit-ridge type nests characteristic of Semotilus atromaculatus and Semotilus lumbee. Males of C. pauciradii excavated pits for spawning in gravel nests of Nocomis leptocephalus in streams of North Fork Broad River of the upper Altamaha River drainage, Georgia at a water temperature of 18 C. Notropis lutipinnis also spawned over these Nocomis nests.

88

SEED, J.R., J.B. SECHELSKI, AND M.R. LOOMIS. Department of Parasitology and Laboratory Practice, University of North Carolina, Chapel Hill, N.C. 27514; North Carolina Zoological Park, Asheboro, N.C. 27203--Resistance to African trypanosomes: Innate serum factors.

African animals show varying degrees of resistance to the African trypanosomes. For example, baboons would appear to be refractory to infection, whereas the hartebeest, although infected, show low parasitemias and no evidence of pathology. In contrast, man and most domestic breeds of cattle are highly susceptible with high parasitemias and severe pathology. It has previously been shown that human plasma is trypanolytic in Trypanosoma brucei brucei whereas the two human infective species, rhodesiense and gambiense, are plasma resistant. It has been suggested that the differences in the resistance of the various African animal species is due to innate plasma factors which are lytic, or could control the growth and development of the trypanosomes in vivo. The identification of such factors, if they exist, could ultimately be important in our efforts to control this infection. The plasma and sera from African animals at the North Carolina Zoological Park have been examined for their ability to influence the growth, development and/or the survival of T. b. rhodesiense both in vivo and in vitro. They have been analyzed by an in vitro neutralization and trypanolysis test; the passive transfer of the samples to infected mice; and by an in vitro growth inhibition test. Supported by NSF Grant PCM-8405262, and NIH Grant TMP 1R01 AI23654-01.

89

SOWADSKY, RICHARD A. University of North Carolina at Chapel Hill--Affects of changing environmental parameters on growth rates of different clones of Trypanosoma brucei gambiense.

When African trypanosomes undergo antigenic variation of their surface coat, a change in parasite growth rate is sometimes seen. It is known that during the infection, there are physiological changes in the host which in turn, may affect the living environment of the parasite. In the present study, we wished to investigate whether these environmental changes play a role in variations in growth rates between clones, both when parasites are grown separately and together. This study utilizes the techniques of in vitro cultivation of bloodstream trypanosomes, as well as in vivo competitions between clones in irradiated animals. Environmental parameters that change in the host during infection, e.g., temperature and CO_2 levels, are being varied in vitro to study the effect(s) of these changes on growth rates of different clones. Since growth rates differ between clones in the same host, it is possible that certain environmental changes may, in part, play a major role in clonal growth rates in vivo. This study is being supported by NSF grant #PCM 8405262.

90

OSBORN, J.M., J.E. HALL and R.E. MILLER. University of North Carolina and Walter Reed Army Institute of Research--Comparison of metabolic profiles of mice infected with Trypanosoma brucei rhodesiense and Schistosoma mansoni.

Prior research has revealed an abnormal urinary excretion of tryptophan metabolites in mice infected with African trypanosomes. Tryptophan metabolism may also be altered during schistosomal infections. Toxic properties of aromatic compounds formed during tryptophan metabolism may contribute to the pathogenesis of these infections. Moreover, these disturbances could have diagnostic and prognostic utility if unique to the infecting organism. Using gas chromatographic -mass spectrometric metabolic profiling techniques, urinary acid metabolites of mice infected with Trypanosoma brucei rhodesiense or Schistosoma mansoni were compared to determine if unique excretion patterns exist. Profiles of mice infected with trypanosomes revealed elevated excretion of indole products of tryptophan transamination, in addition to tyrosine and phenylalanine transamination products. No elevation of aromatic amino acid transamination metabolites were detected in mice infected with S. mansoni. Instead, elevated concentrations of xanthurenic acid, produced from tryptophan metabolism via the kynurenine pathway, were detected. During trypanosome infection, excretion of xanthurenic acid was reduced.

91

LUSHBAUGH, W.B., KLYKKEN, P.C., GENTRY, G.A. University of Mississippi Medical Center, Departments of Preventive Medicine, Pharmacology and Microbiology. Effect of Trichomonas vaginalis secretions on BHK-21 cells.

Complete Dulbecco's MEM conditioned by 18 hr growth of 10^6 T. vaginalis trophozoites/ml produced time and dose dependent reversible alterations in the growth pattern of target BHK-21 cells. Cells treated with T. vaginalis culture factor (TVF) became progressively clumped and detached from the monolayer. TVF dilutions >1:8 formed partially confluent monolayers with overlying palisades at 18 hr. Similar morphologic changes appeared in cells exposed to 1:32 & 1:64 dilutions of TVF only after 48 hr exposure. No changes in cell viability were noted; treated cells formed normal monolayers when TVF was washed off and replaced by TVF-free, complete DMEM. BHK cell growth, as monitored by cell number or DNA content, was not affected by TVF exposure; but ^{3}H-thymidine incorporation was 40% greater/μg DNA with TVF than in controls ($P < 0.001$). Mitomycin C treatment of BHK cells, which prevents DNA synthesis, significantly reduced ^{3}H-thymidine incorporation. We hope to describe fully the biochemical lesion(s) produced by TVF. Trichomonas vaginalis may produce similar host cell alterations in vivo, contributing to the symptomatology of heavily infected women. This study was supported in part by a BRSG NIH grant S07RR0586 and by a grant to PK from the RJ Reynolds/Nabisco Foundation, Inc.

92

JARECKI-BLACK, J.C., A.B. GLASSMAN, K.M. PRATT AND E.R. JAMES. Medical University of South Carolina--Protection against Leishmania donovani using a parasite-derived microsomal fraction.

Our laboratory has been interested in the development of a vaccine as an alternative to chemotherapy in the control of visceral leishmaniasis. We have demonstrated that an immunization protocol combining killed promastigotes and aluminum hydroxide potentiates resistance against L. donovani in a murine model. Presently we are examining parasite antigens in an attempt to identify those that are successful immunogens. Promastigotes were washed, freeze-thawed, sonicated and subjected to differential centrifugation. The microsomal fraction was isolated by high speed centrifugation (100,000 g x 3 hours). C57BL/6 female mice, were immunized s.c. with aluminum hydroxide (25 mg) combined with either 10^7 killed parasites (ALM) or 10^7 parasite equivalents of the microsomal fraction (AMM).

Controls received aluminum hydroxide alone (AL), parasite (P) or microsomal fraction (M) alone, or were untreated (NT). Results showed that mice immunized with either the ALP or ALM regimen exhibited significant ($p<0.002$) resistance against L. donovani challenge as compared to control groups, and both immunization protocols provided similar levels of protection to recipients. This report represents the first successful attempt at immunization against L. donovani with a microsomal vaccine.

93

SUNDERMANN, CHRISTINE A., DAVID S. LINDSAY, BYRON L. BLAGBURN. Auburn University -- *Interaction of lectins with avian Cryptosporidium*.

Cryptosporidium baileyi oocysts were excysted in vitro in 0.75% sodium taurocholate. The final sample, containing empty and intact oocysts and free sporozoites, was incubated in varying concentrations (50-150μg lectin/ml sample) of fluorescein-labeled concanavalin A or wheat germ agglutinin for 15 minutes. Control preparations included 0.1M mannose or N-acetylglucosamine. Samples were rinsed in PBS and viewed. Con A bound to the wall and residuum of empty oocysts; intact oocysts and all sporozoites were negative. No binding of wheat germ agglutinin was observed. The procedure was repeated using samples that were dried and permeabilized. Empty oocysts and their residuums and free sporozoites fluoresced brightly, presumably due to the presence of carbohydrates on the cell's interior. Freshly excysted oocyts were also briefly fixed and treated with ferritin-labeled or peroxidase-conjugated con A; control samples included the appropriate competing sugar. Observation at the ultrastructural level again revealed that labeled lectin bound to the walls and residuum of empty oocysts. Intact oocysts and all sporozoites were negative. (Supported by Alabama Agricultural Experiment Station 13-0061)

94

KIRSCHNER, K.F. and B.J. BOGITSH. Vanderbilt University -- Immunoinhibitory effects of rabbit anti-bovine cathepsin D on schistosomes.

Previous studies indicate a pepstatin-sensitive acid protease exists in the digestive tract of Schistosoma japonicum. Pepstatin is a specific inhibitor of mammalian carboxylendopeptidases such as cathepsin D. Antibodies against purified bovine cathepsin D were raised in rabbits and the polyclonal antiserum was tested to determine (a) its ability to inhibit schistosome's hemoglobinase activity, and (b) its effects on in vitro cultured schistosomules. The 100,000 g supernatant fraction (CEP) from lyophilized adult S. japonicum was preincubated with antiserum followed by incubation with hemoglobin. SDS-PAGE procedures were used to visualize the extent of inhibition by the immune serum. Normal controls were utilized in all instances. Schistosomules incubated in vitro in polyclonal antiserum to bovine cathepsin D did not digest host erythrocytes but did exhibit a normal gastrodermis. Some perturbation of the tegument was evident. Schistosomules fed host erythrocytes and post-incubated in polyclonal antiserum show an increase in perturbation of the tegument and extensive alterations of the gastrodermis such as dilation of cisternae and breakdown of membranes.

95

VANDERGON, T.L., J.H. BURDEN, G.P. NOBLET, and J.M. COLACINO. Clemson University, S.C.--Identification and characterization of hemoglobin of a gymnophallid metacercaria, a parasite of the marine polychaete Amphitrite ornata.

An unidentified gymnophallid metacercaria isolated from the metanephridial sacs of Amphitrite ornata has been determined to possess an intracellular red pigment. Microspectrophotometry of the pigment in vivo shows that the pigmnet is capable of reversible binding with oxygen and has characteristic absorption spectra representing oxygenated, deoxygenated and carbon monoxide derivatives of hemoglobin. The hemoglobin has a high affinity for oxygen with a half-saturation (P50) value = 0.6 - 1.2 mm Hg at 20 °C and pH 7.4, and shows cooperative oxygen binding with a Hill coefficient of about two indicating that the functional hemoglobin may consist of two binding domains. High performance liquid chromatography (HPLC) indicates that the hemoglobin possesses only a single monomeric form. This high affinity hemoglobin may aid the parasite in obtaining oxygen from the vascular erythrocruorin (P50 = 10) or coelomic hemoglobin (P50 = 2.7) of Amphitrite under hypoxic conditions. (Supported by NSF Grant DMB-8600614).

96

BURDEN, JAMES H. and GAYLE P. NOBLET. Clemson University--Occurrence of metacercariae (Trematoda: Gymnophallidae) in metanephridia of Amphitrite ornata (Annelida: Terebellidae).

Gymnophallid metacercariae occur primarily in the extrapallial space of bivalve and gastropod molluscs. Three recorded exceptions are known to use polychaete annelids as second intermediate hosts. The gymnophallid metacercaria under investigation in the present study was first observed attached to the body wall and tentalces of the terebellid polychaete Amphitrite ornata. More recent investigations have revealed what initially appeared to be the seasonal absence of metacercariae attached to the polychaete host and a new observation of metacercariae within the metanephridia of the host. Polychaete hosts under investigation were collected from mudflats of Garden City on the South Carolina coast. Collection and examination of the external surface of host worms was initiated in October 1985. Numbers of unencysted metacercariae (1-9) per host worm were low, and infection rates varied from 3-20% of annelid hosts. In October 1986, however, metacercariae were observed through the body wall to be within the polychaete host. Dissection of one host worm revealed 41 metacercariae in the host's metanephridia. Subsequent observations of 11 polychaete hosts in November 1986 resulted in the collection of 1-7 metacercariae from the external surface of each of six hosts (55%) and 22-150 metacercariae from within the metanephridia of each of 11 hosts (100%).

97

MOBLEY, RONALD W. and GROVER C. MILLER. North Carolina State University--The Bird Schistosome, Gigantobilharzia huronensis, in the laboratory mouse.
White mice were individually exposed to 200 G. huronensis cercariae. Hosts were necropsied on days 3-10 post infection. Lung assays yielded larval forms with a peak recovery avg. of 32% on day 5. Small numbers of larvae could be recovered from the lungs as late as day 10. Larvae were not recovered from sites other than the lungs. Animals examined on days 21-35 contained no larval or mature worms. Mice exposed secondarily (200 cercariae per mouse) on day 42 demonstrated cutaneous petechiae within two days. Recovery of larvae on day 5 was reduced to less than 5 percent of exposure. No larval worms persisted until day 10 in secondarily exposed mice.

98

JETTON, THOMAS L. and BURTON J. BOGITSH. Vanderbilt University--Morphological, cytochemical, and biochemical observations on spermatogenesis and mature sperm in trematodes, with emphasis on schistosomes.
Schistosomes display several unusual features of spermatogenesis and mature sperm structure as compared to other platyhelminths. From the onset of spermatogenesis germ cells separate, thus cytoplasmic bridges or the characteristic "rosettes" of spermatogenic cells of most platyhelminths are absent in schistosomes. Current cytochemical analyses suggest that during spermatogenesis, mitochondrial migration and polarization is an integral part of the process. Cytochemical evidence further suggests that mitochondria fuse in the side of the cell opposite the single centriole and elongating flagellum. Eventually, the mitochondrial aggregate resides in the blunt anterior tip of the spermatozoon adjacent to the elongated nucleus. Golgi activity appears to gradually diminish throughout spermatogenesis. Glycogen is localized within the core of the single axoneme of schistosome sperm, whereas it is localized between the two axonemes in the more typical platyhelminth spermatozoon as exemplified by that of Haematoloechus medioplexus. SDS-PAGE analysis of testicular homogenates of H. medioplexus reveals at least two sperm-specific polypeptides.

99

THONEY, DENNIS A. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia--Morphology of the Oncomiracidium of Heteraxinoides xanthophilis (Monogenea), a Gill Parasite of Spot, Leiostomus xanthurus (Sciaenidae).
Eggs deposited by adult worms collected in the lower Chesapeake Bay were placed in 10 ml of river water (15^{o}/oo) at 22-23°C to observe embryonic development and obtain live oncomiracidia for morphological studies. Some eggs and larvae were fixed in a 2% gluteraldehyde solution for SEM. Eggs were nonembryonated when laid with a long coiled filament opposite the operculate end. The opercular suture became apparent in 6-7 days, just prior to hatching. Larvae were fusiform, measuring about 125 X 55 µm. Cilia occurred in 3 bilateral zones. The anterior zones had 5 ciliated cells each, the middle zones 6 each, and the posterior zones 2 each. A pigmented eye occurred in the anterior third of the body. The gut extended from the subterminal mouth as a prepharynx to the centrally-located globose pharynx and terminated as a blind sac, which appeared to contain yolk globules. The larval haptor consisted of 1 post-lateral and 4 lateral pairs of marginal hooks (18 µm), 1 pair of posterior hooks (46 µm) which had a flexible joint between the handle and blade, and 1 pair of centrally located hamuli (40 µm). Flame cells have 2((1+1)+(1+1)) pattern. Their ducts joined posterior to the saccular gut and extended antero-laterally as 2 ciliated excretory ducts to the level of the pharynx where they exited. This study affirms the close affinities of this species (Heteraxinidae) with other mazocraeideans, especially the Microcotylidae.

100

SPIRA, TIMOTHY P. Georgia Southern College and White Mountain Research Station--Ecological and distributional characteristics of alpine annual plant species in the White Mountains of California and Nevada.
Few species of annual plants occur in alpine environments. This probably reflects the inability of most annuals to successfully complete their life cycle in a single, short, cold growing season. The White Mountains of California and Nevada, however, have an unusually high concentration of alpine annual

plant species. Most (69%) of the 13 annuals which comprise 8% of the alpine flora of the White Mountains occur throughout western North America, yet only in the White Mountains and nearby Sierra Nevada do they grow above treeline. Seven annuals have distributions from the coniferous forest to the alpine, several occur from the desert to the alpine, and two grow from near sea level to the alpine in California. Unlike desert annuals, alpine annuals typically maintain vegetative populations in successive years and several species generally known as annuals (Chenopodium rubrum, Gentiana tenella, and G. prostrata) exhibit a biennial life cycle at high elevations.

101

LOEHLE, CRAIG. Savannah River Ecology Laboratory--Defensive investments in trees: A critical life history parameter.

A model for partitioning energy during growth in woody plants predicts that increasing a tree's lifespan requires increasing the energy invested in protective measures such as thick bark and defensive chemicals. Increased investment in such defenses, however, slows down the growth rate, thereby raising the juvenile mortality rate. Early reproduction also reduces the growth rate. Additionally, the model predicts that rapid growth can substitute for these defenses, but the consequence is rapid decline upon reaching maturity. These predictions are tested with data compiled from the literature for 159 species of North American trees. Data analysis supports predictions of the model. Longevity was increased by increased investments in defenses as measured by volumetric heat content of the wood. Significant differences were found between hardwoods and conifers. Age of sexual maturity was closely predicted by longevity in hardwoods. There was no such relationship for conifers as a whole, though there was for pines. Caswell's model of evolution of life history traits was strongly supported by tree data.

102

KOKESH, AMY C. and DAVID L. EDENS. Marshall University and West Virginia State College--The bog forest community at Cranberry Glades, West Virginia: I arboreal stratum.

An investigation of the arboreal stratum of the Bog Forest Community in the Cranberry Glades Botanical Area, Monongahela National Forest, West Virginia revealed a dominance of northern hardwoods and mixed conifers. The composition was determined through vegetational analysis by use of the list-count quadrat method. Tsuga canadensis, Betula alleghaniensis, Prunus serotina, and Picea rubens were dominant while eight additional species were found to be tolerant subordinates. The vegetation of the lower strata was observed but not quantitatively investigated. These strata are currently under study. The boundaries of the Bog Forest Community were observed to correspond to the low relief of the open bogs which the forest surrounds.

103

MULLER, ROBERT N., PAUL J. KALISZ and THOMAS W. KIMMERER. University of Kentucky--Intraspecific variation in production of astringent phenolics over a vegetation-resource availability gradient.

The chemical constituency of flowering dogwood (Cornus florida L.) and red maple (Acer rubrum L.) foliage was analyzed over a species compositional gradient to test the hypothesis that over subtle gradients of moisture and nutrient availability production of phenolic compounds will be increased on sites of greatest stress. Calcium and nitrogen concentrations declined along the gradient in both species, while phosphorous showed a significant decline only in red maple. Lignin concentrations in both species were unrelated to the vegetation gradient, but astringent phenolics increased by 156% and 159% in dogwood and red maple, respectively. The clear correlation between production of polyphenols and site quality supports previous observations that under conditions of environmental stress production of many secondary compounds is increased, and suggests that this relationship is significant over subtle environmental gradients. Such a relationship is important for a number of processes related to turnover of organic matter and mineralization of elements. Higher concentrations of plant phenolics reduce turnover of organic matter which in turn reduces site quality. The observations of this study imply that a positive feedback may exist in which poor site quality leads to high production of polyphenols which further reduces site quality.

104

SWAB, JANICE COFFEY. St. Mary's College--Vegetation of Inner Mongolia (China).

The Inner Mongolia region of northern China extends east-west over 18° of longitude and is essentially a vast temperate steppe, much like the drier, northern Great Plains of North America. Because rain comes mainly from Pacific monsoons (largely blocked by eastern mountains), the steppe becomes more arid from east to west. Topography is mainly flat but high (1000-1500 m). Rainfall occurs mainly in summer, but all seasons have abundant sunshine. Winter is very cold, but mean temperatures rise to 19°-24°C in summer.
The central grasslands cover about 40 million hectares and are characterized by Stipa spp.,

Aneurolepidium chinense and *Agropyrum cristatum*, along with *Cleistogenes* spp. and *Artemisia frigida*. Herbaceous dicots gradually decrease westward while xerophytic shrubs increase. Along rivers and lakes one finds salinized meadows or marshes with *Carex* spp., *Achnatherum splendens*, and *Suaeda* spp. The eastern mountains rise to 1500-2000 m and support *Larix gmelinii*, *Pinus* spp., *Populus davidiana*, *Quercus mongolica*, and *Betula platyphylla*. The desert areas include scattered sandy plains and rocky areas, accounting for about 10% of China's desert area. These Mongolian desert areas differ from the others by being mainly composed of alluvium moved to their present locations by strong winds. Sand dunes occur frequently throughout (about 64% are mobile), mainly due to destruction of the natural vegetation. *Stipa* spp., *Zygophyllum xanthoxylon*, *Ammopiptanthus mongolicus*, *Calligonum* spp., and *Nitraria* spp. are important in these desert areas.

105

BOX, ELGENE O. University of Georgia -- *Comparing the Natural Vegetation of East Asia and eastern North America.*

East Asia (China, Korea, Japan) and eastern North America (USA, SE Canada, NE Mexico, adjacent islands) occupy almost exactly the same latitudes on continental east sides, yielding similar climatic and vegetation zonation into five main regions: subtropical and warm-temperate evergreen forest types, temperate deciduous forest, boreal and/or montane conifer forest, and small areas of alpine vegetation. Similar N-S mountain and east-coastal orientations yield more similarities and a finer common framework for vegetation study. More general bioclimatic and vegetation patterns are summarized comparatively by maps and tables for three separate regions: mainland East Asia, more maritime Japan, and eastern North America. Japan is the most distinctive, of course, while China and the USA have remarkably similar vegetation zonation (except in the far west). More specific bioclimatic considerations suggest the reasons for both vegetation similarities and differences, including Japan's evergreen broad-leaved forests as far north as 38°N and East Asia's unusual diversity of warm-temperate conifers. An initial attempt is made to summarize both equivalent and unique natural vegetation areas in all three regions. Comparisons can be made conclusively and yet economically by means of standard relevé tables, including comparison of substitute and other secondary vegetation.

106

FUJIWARA, KAZUE. Yokohama National University--*Mangrove forests of East and Southeast Asia, with comparison to eastern North America.*

The mangrove vegetation of E and SE Asia involves a richly developed flora, with probably the greatest species diversity of the world's mangrove regions and with species rather distinct from those of the New World. Mangroves occur in Asia throughout the inter-tidal zone and along coastal rivers but with species zonations sensitive to water and soil salinity, estuarine vs. riverbank location, other aspects of topography, and mud vs. sand substrates. The main vegetation communities in mangroves of E and SE Asia include:

- *Sonneratia-Avicennia* forests, generally along estuaries and lower tidal streams;
- *Kandelia candel* forests, generally more upstream and to the north;
- *Rhizophora* forests over most mangrove area but with some specific requirements:
  - *Rh. mucronata* on muddy substrates over most of the tropical E Asian coastline,
  - *Rh. apiculata* over a wide salinity range (cf. *Rh. mangle* in North America), and
  - *Rh. stylosa* on coral/limestone substrates of Japan and Micronesia.

In the back-mangrove areas, *Xylocarpus*, *Lumnitzera*, *Heritiera*, and *Phoenix paludosa* are especially important. *Bruguiera* forests grow to 30 m on stable sites, including southernmost Japan. The northernmost of all mangrove species in E Asia, however, is *Kandelia candel*, reaching southern Kyūshū, whereas the northernmost species in North America is *Avicennia germinans* (=*A. nitida*). In addition, although *Avicennia* and *Rhizophora* are important in both Asia and North America, the other genera are mostly different.

107

SHARMA, G.K. University of Tennessee at Martin--*Altitudinal variation in the cuticular patterns of Cannabis sativa L. (marihuana).*

Cannabis sativa L. (marihuana) is native to Central Asia, where presumably wild populations of the taxon are found growing in a wide variety of habitats. These wild populations were studied in the plains area and in the mountainous habitats, where the taxon is found even at an elevation of 3,300 meters. Morphological and cuticular features were studied in several populations of *Cannabis sativa*. A significant variation in leaf size and plant height was found among various populations growing at different elevations. Cuticular features such as trichome frequency on leaves and stomatal frequency exhibited altitudinal differentiation. Epidermal wall undulations were found to be variable at different elevations. Some cuticular features such as subsidiary cell complex and trichome type remained unaffected by altitudinal variation. The data seem to suggest some ecological and economic implications.

108

KUO, YAU-LUN and ROBERT O. TESKEY. University of Georgia--*Effects of site preparation treatments on competing vegetation, resource availability, and physiological and growth responses of loblolly pine seedlings.*

Four site preparation treatments were applied on a Georgia Piedmont site. A single chop treatment resulted in a larger amount of hardwood regrowth and less pine growth compared to rake, herbicide, and double chop treatments after three growing seasons. Relative diameter and volume growth of pine seedlings were negatively correlated to the level of competing vegetation on a whole plot basis but the relationships were less pronounced on an individual tree basis, though still statistically significant. Physiological responses of pine seedlings were analyzed according to different water stress periods in the first two growing seasons. Predawn xylem pressure potential (PXPP) of pines was negatively correlated with competing vegetation during mild-stress periods (PXPP between -0.5 to -0.9 MPa) and leaf conductance was negatively correlated to the level of competing vegetation in non-stressed periods (PXPP higher than -0.5 MPa). Both leaf conductance and PXPP were significantly correlated with the amount of competing vegetation and pine growth, suggesting that both physiological responses may be good indices for competition and pine growth.

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Imm, Donald W. and Carl D. Monk. University of Georgia -- Seasonal patterns of leaf weight, surface area and nutrient content of evergreen and deciduous subcanopy plants on a Southern Appalachian hardwood forest.

Evergreen species are more abundant than deciduous species on infertile sites. Evergreens may have slower growth rates and higher nutrient use efficiences than deciduous species, in part because of nutrient storage in previous years foliage, greater sclerophyll content, and higher nutrient resorption prior to abcission. This study quantified seasonal changes in foliar nutrient content (N, P, Ca) as a function of leaf area and dry weight production for each of two evergreen plants (Kalmia latifolia L. and Rhodeodendron maximum L.) and two deciduous plants (Acer rubrum L. and Cornus florida L.). The study was conducted at the Coweeta Hydrologic Laboratory, NC. Fifteen foliage samples were taken from two study plots (20M X 50M) at 12 intervals during one growing season. Preliminary results indicate that the evergreen species have a more gradual increase of leaf area and leaf biomass relative to the deciduous species. Past investigators have suggested that slower growth rates and retainment of past years foliage increases the nutrient use efficiency of plants and infertile soils. Seasonal changes of foliar and soil nutrient contents will also be presented.

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MURDY, W.H., M.E.B. CARTER AND N. WOLFF. Emory University--Regulation of the timing of pollen germination by the pistil in Talinum mengesii.

In angiosperms selection may take place between the time a flower is pollinated and the time its ovules are fertilized. With insect pollination, a surplus of male gametophytes in the form of pollen grains may be deposited on the stigma of a pistil and this provides the potential for gametophytic competition and selection. In all plants examined from two Talinum mengesii populations, pollen germination was delayed for up to two hours after pollination. A third population lacked the delay trait and a fourth population was variable for it. Reciprocal pollinations between plants with and without the delay trait and pollinations at different times during anthesis revealed that the timing of pollen germination was not affected by the length of time it resided on the stigma, but was regulated by the maternal parent. Theoretically, the effect of the delay trait would be to promote the accumulation of pollen on the stigma and induce simultaneous germination. This would intensify intermale competition and provide a mechanism for the maternal parent to influence the paternal parentage of its offspring.

111

NELSON, JOHN B. South Carolina Nongame and Heritage Trust Program--Vegetation on the Iredell soil of the Piedmont of South Carolina.

Soils of the Iredell series occur in twelve counties of South Carolina's Piedmont. These are present over various rock types, which include gneissic schists and gabbro. In general, these soils are thin and rocky, and usually somewhat circumneutral. The development of original plant communities on these sites was no doubt influenced by the chemical and physical attributes of the soil. It is possible that original growth communities may yet occur on some of these sites, bearing in mind the difficulty encountered in dealing with this soil for agriculture. Within South Carolina, the largest expanses of Iredell soil (and its relatives) occur in York County. A number of plant species unusual or rare for South Carolina, and perhaps maintaining a vegetational relationship between this soil type and communities on cedar glades, have been discovered during this study.

112

PAYNE, J. LEWIS, DONALD R, YOUNG and JOHN F. PAGLES, Virginia Commonwealth University--Habitat analysis of the endangered populations of the northern flying squirrel in the southern Appalachians.

To develop a habitat profile for populations of the endangered northern flying squirrel, Glaucomys sabrinus, (G.s. fuscus Miller and G.s. coloratus Handley), plant community and environmental characteristics were quantified at 12 sites in the southern Appalachian mountains. At all of the sites, G. sabrinus had been captured within the past 4 years. The vegetation, including standing dead trees, was sampled with point-quarter and intercept methods while meteorological data were obtained from local weather stations. The sites were further characterized through computer assisted data analyses that included cluster analysis and principal component analysis. The data indicated that the endangered northern flying squirrel inhabits relatively mesic sites above 1100 m which are dominated by *Picea rubens* and mixed northern hardwoods, especially *Fagus grandifolia* and *Betula lutea*. The understory species found to be most common were *Rhododendron maximum* and *R. catawbiense*, as well as numerous ferns. This habitat profile may be used to locate unknown populations and potential sites for possible reintroduction of the northern flying squirrel in the southern Appalachians.

113

BALLAL, S. K. Tennessee Technological University--*The in vitro culture of excised ovules of cotton.*

A culture regimen and many chemical environments were chosen for *in vitro* ovule culture of *Gossypium hirsutum* L. cv Coker 201. Being an allotetraploid, this species evokes considerable interest in genetic and developmental studies. Resistance to certain pathogens and insects, male sterility are of potential importance in tetraploid cotton production. Developmental physiology of embryo maturation in this cultivar approximates that occurring *in vivo*. Of the many nutrient media evaluated, the most optimum one contained an organic nitrogen source and osmoticum. Only 20 to 25 DPA ovules were used in the experiment, which do not seem to have any phytohormone need for maturation. The medium with various concentrations and combinations of phytohormones did not specifically encourage embryo maturation which was measured in terms of germinability. When the denuded embryos were prewashed in sterile water for two hours before transferring to an induction medium, the survival rate increased. When the transfer medium was supplemented with organic nitrogen, more than 80% of the ovules produced mature embryos even though the dry weight did not approximate that of *in vivo* development. These embryos exhibited capability for precocious germination with only one week in culture. Such germinated ovules were established in half strength MS medium solidified with agar for root and shoot establishment before transferring to greenhouse medium.

114

ALL, T.M. and S.K. BALLAL. Tennessee Technological University--*In vitro Organogenesis of a Recalcitrant Xerophyte.*

Among herbaceous plants there are numerous examples of morphogenic expressions of tissue *in vitro*; such expressions are erratic and less defined in many woody species. To study the morphogenic potential *in vitro* of species, Jojoba (*Simmondsia chinensis*) was chosen in this study.

Jojoba is a xerophyte shrub endemic to the Sonoran desert of the American southwest. Jojoba is a dioecious long-living perennial. This species is receiving increased attention because of the rich wax contained in the seeds. This liquid wax is made up of more than 50% wax esters, in contrast to triglycerides found in seeds of common cultivated oil-seed plants. It has been suggested that this liquid wax could be a replacement for sperm-whale oil since the placement of sperm-whales on the endangered species list in 1972. Because of its stable molecular structure, Jojoba "oil" has the capacity to stay pure and uncontaminated during long term use. Jojoba meal, the by-product of the seed extraction process, is also of potential value. This meal contains 30-35% protein and can be used to make an animal feed supplement. Other suggested uses of this oil include lubricants, shampoo, soap and pharmaceuticals.

One method of propagation for this plant is by plant tissue culture. The establishment of callus is a major step in the subsequent establishment of plantlets in culture. A matrix of growth regulators was used to determine the most favorable regimen for callus production and subculturing. Primary explants were placed on modified Murashige and Skoog medium supplemented with various auxins and cytokinins. After the establishment of callus, the same matrix system was used to define the morphogenic parameters.

115

STONE, B.P. and LISA A. STOKES. Center of Excellence for Field Biology of Land Between the Lakes, Austin Peay State University--*Effects of Ca^{2+} Inhibitors on GA Enhanced Hypocotyl Elongation.*

The GA enhanced elongation of lettuce seedling hypocotyl elongation was reversed by diethylstilbestrol, vanadate and cobalt-chloride. The interaction of calcium ionophere A23187 and $CaCl_2$ with the inhibitor reversal of GA enhanced hypocotyl elongation and the effects of these inhibitors on lettuce seedling root elongation will be discussed.

116

SAMUELSON, LISA J. and ROBERT O. TESKEY. University of Georgia--*Photorespiration in loblolly pine.*

Photorespiration was measured in loblolly pine seedlings (*Pinus taeda* L.) using the Warburg method under varying levels of light, temperature and water stress. Rates of photorespiration among four loblolly pine genotypes were also compared. At low irradiance (150 µmoles m^{-2} s^{-1}), inhibition of photosynthesis by ambient levels of oxygen was 25%. This was significantly greater than the inhibition at 300, 700 and 1200 µmoles m^{-2} s^{-1}. Stomatal conductance was significantly lower in 2% oxygen at all light and temperature treatments. Photorespiration doubled with a 10 degree increase in temperature from 15°C to 25°C and tripled with a 20 degree increase from 15°C to 35°C. The temperature optimum for apparent photosynthesis was 25°C. Apparent photosynthesis decreased from 25°C to 35°C whereas no decrease was found when the oxygen concentration was lowered to 2%. Low oxygen concentrations appear to increase the temperature optimum for photosynthesis. Photorespiration was compared among seed sources from Arkansas, Florida, Georgia and North Carolina. The Arkansas and Georgia seed sources had higher rates of photorespiration than the coastal (Florida and North Carolina) sources with the slow-growing Arkansas source having significantly higher rates of photorespiration than the fast-growing Florida source.

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STUMPFF, NANCY J., Lisa A. Donovan and Kenneth W. McLeod. Savannah River Ecology Laboratory, Drawer E, Aiken, South Carolina 29801--High temperature flooding injury of bald cypress and water tupelo seedlings.

Thermal effluents from the Savannah River Plant have modified portions of the nearby swamp forest, ranging from complete elimination of the bald cypress-water tupelo (Taxodium distichum (L.) Richard and Nyssa aquatica L.) canopy to community composition shifts. The aim of this study was to determine how growth and physiology, especially root respiration and ethylene production, of bald cypress and water tupelo were affected by simulated thermal effluents. High temperature (40 C) flooded conditions reduced growth, root respiration and ethylene production rates of both bald cypress and water tupelo, and also affected water relations of water tupelo. Reduced root respiration under high temperature flooding indicates altered metabolism. Root respiration rates did not decrease due to flooding at ambient temperature. Therefore, the roots probably obtained sufficient oxygen for aerobic respiration through internal transport. Decreased ethylene production at high flood water temperatures may have inhibited the morphological acclimation needed for internal aeration under flooded conditions.

118

WATSON, MARK B., ALAN R. WHITE, CHERYL E. WILLIAMS, JAMES P. GILL, and H. WAYNE ELMORE. Marshall University--Bracken Fern polysaccharides.

The polysaccharides of fern cell walls have long been thought to be similar to higher plants. Callus cultures from Bracken Fern, Pteridium aquilinum, were transferred to a liquid medium and optimal conditions determined. (See paper by Webb et al., this meeting.) Vigorously growing cells were isolated, washed and treated with amylase. The polysaccharides were extracted with either alkali or endopolygalacturonase (EPG). The alkali extractions included ammonium oxalate, 0.5M - 4.0M gradient of KOH, and water. The EPG treatment was also followed by 4.0M KOH and water. Each of the fractions were separated with DEAE Sephadex and the glycosyl composition analysed with GC using the alditol acetates procedure. Fern wall polysaccharides were compared to rhamnogalacturonan II (a typical higher plant pectin) which contains several characteristic sugars (i.e. methyl-fucose, methyl-xylose, apiose, and aceric acid). The fern cell walls contained small amounts of the methylated sugars. Aceric acid and apiose were both present in significant amounts. A typical carbohydrate composition was: 72.9% glucose, 12.8% galactose, 6.1% arabinose, 3.8% xylose, 2.2% rhamnose, 1.1% fucose, 1.1% mannose. The low percentage of mannose is not consistent with the presumption (Preston, 1974, Phys. Biol. Plant Cell Walls, p. 54) that glucomannans are the major hemicellulosic component of fern cell walls.

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McLEOD, KENNETH W. and LAURAL J. GLAZER. Savannah River Ecology Laboratory/University of Georgia--Comparative photosynthesis of woody seedlings grown under differing light conditions.

Differing shade tolerance insinuates differential ability to utilize sunlight. In shady habitats, shade intolerant species would not be expected to occur or persist over time. Yet, other environmental factors, such as flooding, may restrict the number of species capable of surviving in an area so as to favor a shade intolerant species. The objective of this study was to determine the photosynthetic response to changing light intensity of plants differing in shade tolerance. Seedlings of button bush (Cephalanthus occidentalis), black willow (Salix nigra), bald cypress (Taxodium distichum) and water tupelo (Nyssa aquatica) were acclimated to light conditions ranging from full sun to 15% sun. Photosynthetic rates of acclimated seedlings were measured at five light intensities. Acclimation to low light intensities decreased photosynthesis of all species, but the decrease was particularly severe in button bush. Bald cypress's photosynthesis rate was low and generally less affected than any other species. Those plants acclimated to low light intensity were unable to fully utilize higher light intensities, as evidenced by declining quantum use efficiency. Persistence of bald cypress and decline of button bush in shady habitats would be predicted based on their photosynthetic response to low light intensity.

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Mycotoxin Effects on Wheat Seedlings: Elongations and $^{65}ZnCl_2$ Uptake and Distribution. JOHN D. REYNOLDS, Department of Biology, Virginia Commonwealth University, Richmond, VA 23284: GERALD C. LLEWELLYN, Department of Health, Bureau of Toxic Substances Information, Richmond, VA 23219: C. E. O'REAR, Department of Forensic Sciences, George Washington University, Washington, D.C. ----: W. V. DASHEK, Department of Biology, Atlanta University, Atlanta, GA 30314.

Aspergillus flavus and A. parasiticus metabolites are carcinogenic, mutagenic, teratagenic, and toxic. Zinc is needed for auxin synthesis and, plant growth and development. Cultivars of Zea mays seedlings differ in Aflatoxin (AFB_1) utilization for $^{65}ZnCl_2$. Investigations of Triticum spp., 'McNair 1003', 'Coker 747', 'Tyler', 'Arthur 71', 'Pioneer' and Wheeler' were undertaken. Seeds were imbibed upon moistened filter paper in an environmental chamber. Uniform seedlings in groups of 20 were selected for analysis of AFB_1 within a solvent or control solvent. Effects on both organ lengths and possible $^{65}ZnCl_2$ uptake/distribution were evaluated. Ten micrograms AFB_1/ml decreased both 'Pioneer' and 'Wheeler' leaf lengths by 4 and 12%, respectively, and root lengths by 25% and 63%. AFB_1 enhanced 'Pioneer' stem lengths and it reduced 'Wheeler' stem lengths by 13%. Inclusion of 10 ug AFB_1/ml into the medium resulted in 8 and 4% diminutions as well as 1.26 and 1.14 fold enhancements in 'Arthur', 'Tyler', 'Coker' and 'McNair' leaf lengths respectively. These seedling were found to respond to aflatoxins to various degrees.

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MARY L. DAVIDSON and ARMANDO A. DE LA CRUZ Mississippi State University -- Toxicants from leaves of mangrove plant Aegiceras corniculatum.

The toxicity of leaf extracts of the mangrove plant, Aegiceras corniculatum were tested against juvenile tilapia fish. The objectives of this experiment were to determine if the concentration of toxin varies between young and mature leaves, and in mature leaves at different stages of decay. A series of 96-hour bioassays were run and LC_{50} values were calculated. LC_{50} values were 0.273 ppt and 0.137 ppt for young and mature leaves, respectively. Known amounts of mature Aegiceras leaves were randomly collected and enclosed in nylon mesh bags. The bags were deployed in the field and allowed to decompose in situ. The litter bags were retrieved and the contents were washed, air dried and extracted. Aegiceras leaves decomposed for thirty days did not show toxicity to tilapia, indicating that the toxin readily decomposes or leaches out of the tissue. Fractionation and purification of Aegiceras extracts resulted in the isolation of 5-O-methyl embelin. Chromatography analysis revealed that 5-O-methyl embelin is the active toxin in leaf extracts.

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MASSEY, JIM, NANCY COILE, JIM MATTHEWS, and CINDY AULBACH-SMITH. University of North Carolina-Chapel Hill, University of Georgia, University of North Carolina-Charlotte, and University of South Carolina--Forum for Herbarium Curators and Users: Space and Fumigation Problems in Southeastern Herbaria.

A brief discussion of problems relating to space and fumigation of collections and a tour of the University of Georgia Herbarium to see the new compactor system. Participants are urged to bring names and sources of fumigants.

123

MONRAD, JOHN R. Eastern Kentucky University--Tectonics, eustatics, and the evolution of drainage systems in the southeastern United States.

Drainage systems in the southeastern United States evolved in response to events occurring over the past 300 million years. The major events fall into two general categories: vertical motions of the crust, in response to plate convergence, plate divergence, and sedimentary loading; and eustatic sea level changes, in response to climatic variations and rate of ridge-spreading activity. One major effect of these events was to increase periodically the regional relief and slope, which in turn affected the initial orientation of major drainages and the rate of system development. For example, long-lived westward drainage from the Appalachian core region was further enhanced by regional uplift and overthrusting accompanying Late Paleozoic convergence of North America and Eur-Africa; development of eastward drainage was delayed until Mesozoic divergence. Other effects, which included the development of regional structural fabrics and lithologic patterns, were less profound initially. However, their importance as controls on local drainage evolution increased as denudation progressed.

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FITZPATRICK, J. F., JR. University of South Alabama--Evolution of southeastern drainage systems: Zoogeographic considerations.

The diverse geological associations and history of the drainages of the southeastern United States are reflected in a rich and varied fauna. Many of the established ideas of the zoogeographic relationships of the faunae have been reevaluated in recent scholarship and called into question. Among the groups studied are fishes, crawfishes, cladocerans, and pelecypods. These four animal taxa are the focus of discussion which suggests that the present "tried and true" concepts of faunal (and by implication, floral) history of the aquatic ecosystems need to be reexamined in detailed, microgeographic fashion. Increasing understanding of the taxonomy of the biota, especially of the invertebrates, makes this an especially fruitful time to undertake finely discriminated studies of distribution, relating the environmental and historical--geologic and bioevolutionary--parameters that determine precise reasons which cause an organism to occur in a precise locality.

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MULHOLLAND, PATRICK J. and DAVID R. LENAT. Environmental Sciences Division, Oak Ridge National Laboratory, and North Carolina Division of Environmental Management--*Biotic communities of streams of the southeastern Piedmont, Atlantic drainage*.

In general, the biota of Piedmont streams are heavily influenced by human activities and have not received much study. Stream gradients and morphology vary considerably with local geology, topographic relief and land use. Extremely high rates of erosion, particularly during the early 1900's, and channelization have resulted in extensive sedimentation of stream beds and narrow, often unstable stream banks. Solute concentrations in undisturbed streams are generally low (but somewhat higher in the Carolina Slate belt than in other regions); however, most streams have elevated concentrations of nitrogen and phosphorus resulting from extensive agriculture and urbanization. In urban streams low dissolved oxygen concentrations and high levels of metals and toxic organics are also a problem. The periphyton community is often sparse because of heavy silt loads and unstable sediments, but dense growths of diatoms, green, and blue-green algae can occur during periods of stable flow, particularly in nutrient-enriched streams. Macrophytes are scarce. Macroinvertebrate communities are generally dominated by Ephemeroptera and Diptera, with the exception of Carolina Slate belt streams, dominated by Trichoptera. Fish communities vary greatly with stream size and disturbance, and are generally less rich than in Coastal Plain streams. Support was provided by the U.S. Department of Energy under Contract No. DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

126

BECKETT, DAVID C. University of Southern Mississippi--*An ecological comparison of the Ohio and Lower Mississippi Rivers*.

Major water quality differences among Lower Mississippi River habitats are related to the presence or absence of current. Lotic habitats in the Lower Mississippi, such as the main channel and secondary channels, always have high suspended solids concentrations, high turbidities, and low water transparencies. Such physical characteristics result in low algal biomass, more stable pH and dissolved oxygen levels, and the constant availability of algal nutrients. Lentic areas in the Lower Mississippi have relatively lower suspended solids and increased water clarity. Because of its impoundment, the Ohio River shows marked water quality differences over the yearly discharge cycle rather than among habitats as in the case of the Lower Mississippi River. The same macroinvertebrate taxa dominate solid substrates in strong current areas in both rivers. The clay-burrowing mayflies do not seem to be nearly as abundant in the Ohio as in the Lower Mississippi, perhaps because of the difference in the composition of the banks. Both rivers show a main channel - backwater dichotomy in ichthyoplankton composition. Drum dominate main channel ichthyoplankton collections while larval *Lepomis* and clupeids are present in much higher densities in the backwaters than in the main channel. Adult shovelnose sturgeon, blue sucker, and blue catfish seem to be much more abundant in the swiftly moving Lower Mississippi than in the Ohio. While dike field middle bars are important nursery areas for young-of-the-year fishes in the Lower Mississippi, the tributaries and perhaps its islands serve the same function in the Ohio River.

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KIMMEL, BRUCE L.,[1] SOBALLE, DAVID M.,[1] KENNEDY, ROBERT H.,[2] and GAUGUSH, ROBERT.[2] Environmental Sciences Division, Oak Ridge National Laboratory[1]* and Environmental Laboratory, USAE Waterways Experiment Station[2] -*Biotic communities of the Southeast: Reservoirs and river-reservoir systems*.

Primarily during the past 50 years, dam construction associated with water and power development projects has converted rivers throughout the Southeastern United States into regulated series of impoundments. These "man-made lakes" serve valuable purposes (including flood control, hydropower production, navigation, water supply, and recreation); however, their construction has resulted in the extensive conversion of riverine, riparian, and floodplain habitats into "river-lake hybrid" environments, which are poorly understood ecologically. In this paper, (1) we will examine the extent of river modification by reservoir construction in the Southeastern United States and discuss some of the ecological consequences of this conversion, (2) we will attempt to place reservoir ecosystems in ecological and limnological context with respect to rivers and natural lakes, and (3) we will argue that the ecology of reservoirs located in multiple-impoundment series (for example, those on the Tennessee, Cumberland, Catawba, and Savannah Rivers) should be viewed in the context of the ecological and limnological dynamics resulting from river-basin-level reservoir operations.

*Operated by Martin Marietta Energy Systems, Inc., under Contract No. DE-AC05-84OR21400 with the U.S. Department of Energy.

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MOORE, RICHARD H. Coastal Carolina College, University of South Carolina--*Biotic Communities of the Southeastern United States : Freshwater Backbays and Lagoons*.

Freshwater Backbays and Lagoons are peripheral to most better-known estuarine habitats. Additionally, they often fall outside of those areas tradionally supported by funding agencies and as a consequence are among our least studied and least well-known aquatic habitats. Trinity Bay (Galveston Bay System), Lake Pontchartrain, the back bays of Mississippi Sound, East Bay (Apalachicola Bay System), the Indian River Lagoon, and the Albemarle and Pamlico Rivers illustrate the varieties of freshwater backbays, lagoons, and related ecosystems supporting a similar biota. Typically shallow, their hydrology and sedimentology are, in the absence of significant tidal variation, principally affected by the wind. Low salinties produce a unique physicochemical environment which supports a biota of varying richness and diversity. Open waters often overlay submerged meadows of sea grasses and macroalgae. Bordering marshes exhibit a high plant diveristy, while maintaining productivities that equal or surpass those of salt marshes from the same latitude. Although less diverse than either pure freshwater or marine communities, lagoonal animal communities are typically dominated by a small number of species, yet they also support large numbers of transitory species which utilize these habitats as nurseries, feeding areas, and refuges from predators, parasites, and diseases.

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KING, PATRICIA S. University of Georgia --Comparative population genetic structure of two species of beetles on outcrops in the Southeast.

Collops georgianus (Coleoptera: Melyridae) is endemic to granitic rock outcrops in the Piedmont of Georgia and is replaced by *C. tricolor* (*sublimbatus* type) on outcrops to the east in the Carolinas, to the west in Alabama and to the north in the mountains of Georgia. The species, though readily identifiable, are very similar morphologically. This study determined the level of genetic variability within and between these species using starch gel electrophoresis of proteins. It was found that the average genetic distance between species (Roger's distance, D = 0.529) was greater than among populations within either species though the within-species variation of *C. tricolor* (D=0.452) was much greater than that of *C. georgianus* (D=0.210). Significant substructuring of both species was evidenced by the use of Sewel Wright's F-statistics and a hierarchical analysis showed that the locality differences contributed more to the overall substructuring of these two species than did the species differences. The greater genetic diversity within *C. tricolor* can be explained in part by the greater geographic area which it covers. However, this alone does not explain the actual geographic pattern of variation. Spatial autocorrelation and Mantel analyses were performed to investigate this further. These suggest that patterns of dispersal among these spatially disjunct populations have been important determinants of the current pattern of genetic variation.

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BEATTY-DeSANA, JEANNE W. GA Retardation Center (DHR)--Human chromosome response to genetic/environmental influences.

Birth defects, developmental delay, and cancer are frequently associated with chromosome changes. Viruses, X-rays, drugs and chemicals cause chromosome breaks and/or nondisjunction. Human lymphocyte cultures are used to diagnose these conditions and reflect environmental exposure. Cytogenetic studies, including G-, R-, C-, and Q-banding of chromosomes, have been carried out for 16 years in a diagnostic and research program. Screening of patients with physical and mental deficits has resulted in identification of chromosome syndromes in 25%. These include autosomal and sex chromosome trisomies, as well as duplications and deletions of a small part of a chromosome. Some are found to have balanced translocations or mitotic instability, both of which would increase reproductive risks. Most of the rearrangements seem to occur randomly, although some are nonrandom. Cytogenetic banding techniques have proved useful in identifying those chromosomal segments which would be expected to have a phenotypic effect. Slides of chromosomes and patient characteristics will be used to illustrate genotype and phenotype.

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LEBERG, PAUL L.,[1] PETER W. STANGEL,[1] JULIA I. SMITH,[2] and JAMES EARL KENNAMER.[3] University of Georgia's Savannah River Ecology Laboratory,[1] University of California at Berkeley,[2] and National Wild Turkey Federation[3]--Influence of restocking on the genetic variability of wild turkeys.

Wild turkey populations have been established in many parts of the southeastern United States through restocking efforts of conservation agencies. Genetic variation of 13 turkey populations with different stocking histories was assessed for 30 loci using starch gel electrophoresis. Turkeys exhibited levels of heterozygosity similar to those of other bird species (3.4% vs. 5.7%, respectively) but had higher levels of interpopulation differentiation than other birds (0.11 vs. 0.02 mean Fst, respectively). Mean individual heterozygosity of turkeys from stocked populations was 37% lower than the mean heterozygosity of turkeys from native, unstocked flocks. Genetic similarity of populations was correlated with their stocking histories. It appears that stocking with small numbers of individuals has resulted in genetic bottlenecks in many of the newly established populations. These results have important consequences for the design of wildlife restoration programs.

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STANGEL, PETER W. and MICHAEL H. SMITH. University of Georgia's Savannah River Ecology Lab--Refuge design and the dynamic genetic nature of natural populations.

Numerous recent studies have suggested the dynamic nature of allele frequencies in natural populations. Virtually all organisms studied exhibit some degree of spatial genetic structuring. Long-term studies have revealed significant shifts in allele frequencies within populations over time. The genetically dynamic nature of populations is rarely, however, considered in the design of wildlife reserves. As increasing numbers of species are forced into small, isolated refuges, genetic considerations become of paramount importance. The maintenance of genetic variability is critical for the short-term fitness of individuals and to ensure the long-term evolutionary flexibility of populations. We propose the use of habitat corridors connecting refuges to increase effective population size (Ne) and facilitate gene flow among isolated refuges. Increasing Ne minimizes loss of genetic variability from inbreeding and drift. Habitat corridors preserve the potential for natural genetic exchange among demes, averting the deleterious effects of genetic isolation. Habitat corridors further reduce the necessity for human intervention (e.g. artificial gene flow) in the genetic management of populations.

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SCRIBNER, KIM T., The University of Georgia's Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29801--Environmental components of spatial differentiation in genetic and life history traits in Hawaiian populations of mosquitofish.

Populations of the mosquitofish (Gambusia affinis) were collected in 17 reservoirs from three islands in Hawaii. Analyses were conducted to explain short-term spatiotemporal evolution of genetic and life history characteristics and to test existing theories of organismal adaptation in uncertain environments. Significant variation in life history and genetic characteristics were found between fish stocks collected from reservoirs characterized as stable and fluctuating based on degree of water level fluctuations. Fish from fluctuating reservoirs showed significantly higher reproductive allocation (22.15 vs 16.33) and heterozygosity (H=0.158 vs 0.134) than those from stable reservoirs respectively. Significant positive correlation was observed between levels of interpopulation genetic and life history differentiation and inter-reservoir differences in water chemistry. This predictability was observed in absence of detectable effects of gene flow among reservoir populations. High H and lack of common allele fixation argue against purely stochastic explainations for observed genetic and life history variation. High environmental variance, the direction of $\bar{H}$ effects and significant $\bar{H}$ correlations with life history traits suggest a form of disruptive selection as the predominant cause of localized fitness which empahsized different combinations of alleles.

134

ANGUS, ROBERT A. University of Alabama at Birmingham--Genetic and biochemical studies of pigment variants in Poeciliid fishes.

Gold sailfin mollies (Poecilia latipinna) are albinos lacking the pigment melanin. Their skin contains an abundance of gold pigment which has been determined to be beta carotene. The gold phenotype is inherited as a single recessive gene. Tyrosinase assays measuring the incorporation of ^{14}C-tyrosine into melanin indicate that gold mollies are "tyrosinase-positive" albinos. Extracts of gold molly skin produce melanin in vitro as well as do extracts from wild-type mollies. The "salt and pepper" phenotype of sailfin mollies is due to the presence of macromelanophores scattered over the body. Mating studies have determined that the macromelanophore pattern is due to a single autosomal temperature-sensitive gene. Penetrance and expressivity of the gene is maximum when fish are raised at cool temperatures (22°C) and minimum at warm (27°C) temperatures. Biochemical assays of tyrosinase activity comparing wild-type and macromelanophore-bearing fish at different temperatures are under way. Pure-breeding stocks of macromelanophore-bearing mosquitofish (Gambusia affinis) have recently been produced. Preliminary data indicate that macromelanophores in mosquitofish are due to a single temperature-sensitive sex-linked gene.

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MCDONALD,MARA A. Savannah River Ecology Laboratory (University of Georgia) and the University of Florida--Age-dimorphism in plumage and increased levels of genetic heterozygosity in juvenals of Hispaniolan Palm Tanagers.

To date, studies of neoteny in birds have not addressed changes in genetic heterozygosity related to the age-dimorphism seen in other character sets. Juvenals of the Black-crowned Palm Tanager, *Phaenicophilus palmarum*, differ from adults in some foraging behaviors, plumage characters, and increased levels of genetic heterozygosity. Of the 39 presumptive loci detected by starch gel electrophoresis, 17 were polymorphic in this species. 12 of these variable loci showed higher levels of genetic heterozygosity for the juvenals than for the adult. Simulation studies, removing one variable locus at a time, with replacement, demonstrated that no one locus changed heterozygosity differences significnatly; therefore, this is a multilocus phenomenon. This increased level of genetic heterozygosity can be explained by artifacts due to small sample sizes, developmental changes in enzymes, differential dispersal by genotype in a non-equilibrial setting, or selection for heterozygotes under stressed environmental conditions. The first two hypotheses are ruled out. The problem left is to distinguish between differential dispersal by genotype or selection for heterozygotes in the juvenile age-class.

136

HOWARD, JAMES and FRED ALLENDORF. Frostburg State College and University of Montana--Heterozygosity and developmental stability in cutthroat trout.

Counts of six bilateral meristic characters that exhibit fluctuating aymmetry were taken on the left and right sides of 102 cutthroat trout. Tissues taken from all specimens were examined with starch gel electrophoresis. 64 isozyme loci were resolved in all specimens. Previous research suggested a significantly negative correlation between heterozygosity and levels of fluctuating asymmetry in the population examined. Our recent analysis, based on more loci and a larger sample size, does not support that view. The correlation between heterozygosity and fluctating asymmetry was r=0.2, and was not significant. A test between the original correlation and this most recent one shows that the two estimates are significantly different. Despite the lack of a significant relationship some evidence persists that fluctuating asymmetry may be negatively associated with developmental rates. In three, four and five year age classes, fish size and levels of fluctuating asymmetry are negatively correlated.

137

MULVEY, MARGARET, JOHN M. AHO, MICHAEL H. SMITH, AND CHARLES LYDEARD. Savannah River Ecology Laboratory--Spatial differentiation in a host-parasite system: Genetic variation in the liver fluke, *Fascioloides magna*, and white-tailed deer.

The potential of multilocus electrophoretic studies for providing insight into the population biology of parasitic organisms was studied using the deer liver fluke, *Fascioloides magna*. Forty discrete hunt compartments representing a mosaic of bottomland hardwood and upland pine/oak forests on the Savannah River Plant (SRP), Aiken, SC, were sampled over a three month period in 1985 and allele frequencies estimated for seventeen loci encoding enzymatic and nonenzymatic proteins. Of eleven polymorphic loci, nine were in accordance with Hardy-Weinburg equilibrium. Deviations were observed for the Aconitase and Malate dehydrogenase loci, and are suggestive of genetic substructuring of the parasite population within the deer herd on the SRP. Temporal and spatial genetic variation also occurs within the deer herd, the extent of subdivision being comparable to patterns exhibited by the parasite. There is, however, no clear pattern of differentiation for either host or parasite with respect to either habitat type or locational position along various stream courses. This lack of environmental correlation suggests a form of disruptive selection as the predominant cause of the localized patterns and is supportive of predictions from Wright's Shifting Balance Model.

138

KORGI, ALBERT and JOHN W. HARRIS. Tennessee Technological University--Biochemical taxonomy and genetic variability in the crayfish genus *Orconectes*.

Electrophoretic analysis of 16 biochemical loci was used to investigate the taxonomic relationship between the Nashville crayfish, *Orconectes shoupi* Hobbs, and an undescribed species of *Orconectes* (*O.* sp.) found in Mill Creek, Nashville, Tennessee. A mean Nei's coefficient of genetic identity (I) value of 0.839 was obtained upon comparison of all samples of *O. shoupi* with all samples of *O.* sp., indicating that they belong to two separate, but closely related, species. Mean heterozygosity (H) values of 0.129 and 0.109 were calculated for *O. shoupi* and *O.* sp., respectively. These values are significantly higher than those previously reported for decapod crustaceans and may reflect environmental unstability. Adaptation to the heterogenous conditions found in Mill Creek may require increased genetic variation.

139

KEELER, CLYDE E. Director of the Research Department Emeritus-- The Albino Syndrome.

(A) Because my 22 field studies on 146 Albino Cuna Indians revealed fine hair on appendages, energy deficiency, alcohol and tobacco hypersensitivity, metabolic odor, tendency to develop skin cancers as Director of the Research Department I requested facility and staff cooperation from Central State Hospital, Orville H. MacKinnon, Superintendent, to implement my NIH Grant GM 10472-01 for clinical study. (B) Six Cuna Albino males and six brown controls, paired for sex and age were examined at CSH in all clinics of the hospital by my research team of 17 staff members, 12 of them having doctorates in their specialties. (C) Our findings were: Albinos inferior to controls in height and weight, bones gracile, less calcified. Cartilage hypertrophied in nose, throat and ear pinna. Skin is pink, dry and myxedematous, occlusion of sweat pores. Deep furrows at neck and elbows. Hairy appendages. Repulsive metabolic odor. Markedly reduced malar eminences. Protruing mandible. More gradually slanting forehead. Dulled senses of smell and taste. Inferior strength. Albinos are myopic with lateral nystagmus and progressive loss of cones. Albino fingerprints differ statistically from those of controls. Albinos frequenly die young from squamous cell carcinoma.

140

MOSER, MARY L. North Carolina State University--Feeding activity of juvenile spot, Leiostomus xanthurus, after rapid salinity changes.

Estuarine organisms are often confronted with rapid salinity fluctuations. The direct metabolic costs of tolerating salinity change are reportedly low for juvenile spot, a common estuarine species. However an indirect energetic toll may be exacted if salinity stress disrupts feeding behavior. Feeding rates of groups of spot were measured after the fish were exposed to salinity changes ranging in frequency from 17-31 ppt/hr and in amplitude from 10-34 ppt. Group feeding rates ranged from 32-164 mg/gww/hr and there were no significant differences in feeding rates of control and salinity stressed fish. The physiological adaptability of spot to salinity fluctuation is reflected in their ability to feed normally soon after exposure to rapid salinity changes.

141

BIRKHEAD, WILLIAM S. Columbus College--Population structure of the bandfin shiner, Notropis zonistius, in two small piedmont streams in westcentral Georgia.

The bandfin shiner, Notropis zonistius, is largely restricted to the Chattahoochee river system where it inhabits small to medium sized clear flowing streams with well developed pools. This species was found to predominate the ichthyofauna of small streams that drain Pine Mountain in westcentral Georgia. The color of the band on the dorsal fin from which this species derives its name was found to be correlated with size, reproductive condition and sex. Most of the large, ripe individuals of either sex possessed black bands, while the bands of smaller individuals with latent or developing gonads were either brown (males) or orange (females). Juvenile fish were unbanded. Adult bandfin shiners that inhabitated a stream into which rainbow trout, Salmo gairdneri, had been introduced were more numerous and larger in size than those inhabiting a comparable stream nearby in which trout were absent. It was originally felt that shiners in the stream that contained trout were feeding on trout chow used in the stocking operation and that this dietary supplement may have accounted for their greater numbers and larger size. Because these population differences were still evident two years after stocking efforts had ceased, and the trout had disappeared from the stream, other factors such as the relative size of the pools in the two streams are being examined in order to explain these results.

142

CRUMBY, W. DENNIS and FRANK J. BULOW. Tennessee Technological University--Growth dynamics of an introduced population of redeye bass in a north-central Tennessee stream.

Redeye bass, Micropterus coosae, in Roaring River, a tributary of Cordell Hull Reservoir, were sampled during 1985 and 1986 to determine if changes in growth rates have occurred since the reservoir was impounded. Scale samples were removed from 190 redeye bass collected by either electrofishing or rotenone application. Otoliths were removed from 95 of these bass for use in validation of the scale method. An attempt to validate with recaptured tagged fish was unsuccessful. Clarity of annulus formation was consistently better on otoliths than on scales. This population of introduced redeye bass is thriving and has apparently not been negatively affected by impoundment of the Cumberland River to form Cordell Hull Reservoir.

143

QUISENBERRY, SCOTT S. and FRANK J. BULOW. Tennessee Technological University--Comparison of scale and otolith techniques for determination of age and growth in rock bass (Ambloplites rupestris).

The conventional scale reading technique for age and growth determination was compared to using photographs of otoliths for the same purpose. Age determinations derived from these two methods were compared to age found by breaking whole otoliths in half and reading them with low magnification. The use of otolith photographs produces a higher degree of precision with repeated readings than the scale method. Age was also more easily determined with pictures of whole otoliths than when viewing broken otoliths under a microscope.

144

HALES, L. STANTON, JR. AND GENE S. HELFMAN. University of Georgia--Growth and mortality of spot (Leistomus xanthurus) in the Stono River estuary, South Carolina.

Young-of-the-year spot were collected biweekly with seines and block nets in different parts of several creeks of different salinity from late May through September, 1986. Age was estimated by analyzing daily growth increments on otoliths. Regressions of length on age were compared for the different creeks. Mortality rates were estimated from decreases in catch rates over time. Immigration of spot into the different creeks was compared. Catch differences suggested that spot actively select certain creek habitats. Preliminary results suggest that marsh habitats may differ in their capacity as nursery areas for spot, and that both physical (temperature and salinity) and biological factors (predation and competition) affect habitat selection in this abundant species.

145

RAMEY, BARBARA A. and LEE A. COLTEN. Eastern Kentucky University - - Avoidance responses of juvenile fathead minnows to acid pH.

Sublethal effects of sulfuric acid on juvenile stages of the fathead minnow (Pimephales promelas) were examined in a preference/avoidance bioassay. Fathead minnows (6- and 14-wk) were exposed to sulfuric acid at pH's ranging from 3.61 to 6.91. The 14-wk fathead minnows avoided pH's below 6.0, while the 6-wk animals avoided all acid levels tested. Therefore, the 6-wk minnows appeared to be more sensitive to acid stress. To provide a basis for comparison, 96-hr acute bioassays were conducted with 8- and 12-wk fathead minnows. Both ages survived 100% at pH's of 5.02 to 7.38, while complete mortality occurred at pH's below 3.92. Based on these findings, juvenile fathead minnows, given a choice, would tend to avoid acid levels that might not prove lethal to them.

146

HEINS, DAVID C. Tulane University--Proximal variation in the reproduction of the longnose shiner, Notropis longirostris.

Annual variation in the timing of the reproductive season and seasonal variation in the clutch size of Notropis longirostris from southern Mississippi were studied. The start of the reproductive season varied about one month (beginning in February or March) in seven years. Termination of the reproductive season varied about two-thirds of a month (ending in October or November) in five years. Examination of ovaries from specimens collected in the field showed that N. longirostris produces multiple clutches of ova. Analysis of seasonal variation in clutch size showed significant differences in clutch size-standard length relationships with time.

147

WINNER, BRENT L. University of North Carolina at Wilmington--Categorization and length-depth comparisons of deepwater sharks.

The purpose of this study was threefold: to compile a list of all deepwater sharks; to categorize them based on various criteria; and to determine the correlation between maximum total length of a species and the depth it inhabits. A literature review was done for all species of sharks known to date. The parameters examined were: total length at maturity; maximum and minimum depth inhabited; habitat/biology; and zoogeographical distribution. A deepwater shark was defined as any shark recorded to inhabit waters below 200 meters. One hundred eighty-four species of deepwater sharks, which are represented in 6 orders and 19 families, were identified. Lifestyle categorization was the best criterion to separate the deepwater sharks into comparable groups. Five lifestyle categories were used: resident; age/mating separation; tropical submergence; diel migration; and transient. Mean total length at maturity showed a decrease with greater depths inhabited by a species. This correlation between total length and depth inhabited was directly related to the lifestyle of a particular species. For example, resident deepwater sharks spend their entire lives at greater depths than any of the other deepwater sharks, and have the smallest mean total length at maturity. However, a comparison of total length and depth inhabited showed no statistical correlation.

148

KANEHL, PAUL D. Tennessee Technological University--The rainbow trout fishery of the Center Hill Dam tailwater.

The Center Hill Dam tailwater has supported an important put-and-take and put-grow-and-take rainbow trout, *Salmo gairdneri*, fishery for the past thirty years. The Tennessee Wildlife Resources Agency maintains an extensive stocking program in these waters, however no evaluation of this program has ever been made. Therefore, the objectives of this study are to determine the age, growth and movement of stocked rainbow trout. All fish were fin-clipped prior to stocking and mean monthly growth rates were determined. Growth rates averaged 16.0 mm per month for the first six months and then gradually declined. Movement of rainbow trout was determined through the use of tagged fish. From electrofish samples and tag returns, it was found that the majority of fish (66%) stayed near the stocking site, while 20% moved downstream and the remaining 14% moved in an upstream direction.

149

Maurakis, E. G.,[1] R. G. Otto[2] and E. S. Perry,[3] Potomac Electric Power Company[1], R. G. Otto & Associates[2] and University of Maryland[3].--Factors affecting electrofishing efficiency for redbreast sunfish (*Lepomis auritus*).

An analysis was made of the effects of water temperature and conductivity on electrofishing efficiency for redbreast sunfish using a pulsed DC electroshocker. Seasonal measurements of electrical field dimensions in the Potomac River, Maryland were made within and outside the thermal effluent of Potomac Electric Power Company's Dickerson Steam Electric Station. Electric field dimensions of an electrofishing boat were related to laboratory-defined dose-response curves that defined the susceptability of various sizes of redbreast sunfish to electroshock. Field size increased with water temperature and conductivity. Stun voltage (estimated voltage necessary to immobilize 50% of the specimens for 10 sec or greater) varied with specimen size and test conditions (temperature and conductivity). Generally, smaller fishes were less sensitive than larger ones and fishes at summer temperatures were more sensitive than the same size fish under colder, winter conditions.

150

ORRELL, THOMAS M. and WOOLCOTT, WILLIAM S. University of Richmond -- A phenetic analyses using the skeletal characters of nine species of darters: *Percina* (*Alvordius*).

Nineteen characters of five skeletal components of nine species of darters, *Percina* (*Alvordius*), were used to develop a phylogenetic hierarchy. Pertinent skeletal structures were coracoid, premaxilla, premaxillary teeth, neurocranium, number of vertebrae, and position of first dorsal and anal pterygiophores relative to the numerical sequence of vertebrae. A phenogram developed from a dissimilarity matrix showed the following relations within *Alvordius*. *Percina macrocephala* and *P. notogramma* were most closely related to *P. peltata*, which was directly related to *P. crassa* and *P. maculata*. The nearest relationship to this species complex was *Percina* sp. and *P. roanoka* followed in order by *P. pantherina* and *P. gymnocephala*. (Supported in part by a Univ. of Richmond Undergraduate Reaserch Grant.)

151

KING, MARK A.,[1] ROBERT G. GRAHAM,[2] and WILLIAM S. WOOLCOTT.[3] Virginia Commonwealth University,[1] Virginia Power Company,[2] and University of Richmond[3]--A comparison of growth of *Micropterus dolomieui* (smallmouth bass) from the North Anna and the South Anna rivers, Virginia.

Growth was calculated for smallmouth bass from Piedmont sections of the North Anna and the South Anna rivers (York River basin). Growth of smallmouth bass in the North Anna River compared favorably to the best reported growth of the species in rivers and streams throughout North America. Lengths of North Anna River smallmouth bass were significantly greater ($p<.05$) for some year-classes (ages one, two, three, and four) than were lengths of those in the South Anna River. This was attributed to more extensive smallmouth bass habitat in the North Anna River, which may have reflected the influence of Lake Anna, a major impoundment of the river. Influential factors include: 1) a minimal water release of 1.1 m^3/s, (2) decreased turbidity from storm runoff, and (3) higher fall and early winter temperatures. Water quality in the North Anna River prior to impoundment was degraded by acid mine runoff from a last century iron mine. Consequently, the smallmouth bass population was more recently established in the North Anna River, and therefore fish probably were exposed to optimal conditions of low intraspecific competition and abundant prey. The study was supported in part by Virginia Power Company and Virginia Commonwealth University.

152

ORVOS, DAVID R., GEORGE H. LACY, and JOHN CAIRNS, JR. Virginia Polytechnic Institute and State University--Use of soil microcosms in evaluating survivability of a genetically engineered microorganism.

To determine the feasibility of using self-contained systems to evaluate environmental effects of genetically engineered microorganism (GEM) release, soil microcosms, using 200 g of non-sterile no-till soil in 1 l glass jars, were used to ascertain the survivability of a GEM. The bacterium, Erwinia carotovora L-827 containing an ampicillin-resistant gene, decreased from an initial mean population of 7.25×10^7 to 1.35×10^7 CFU/g wet wt after 10 d incubation at 25° C. These results indicate that the organism was able to colonize the substrate and compete, even if transiently, with indigenous organisms and that microcosms will be useful in determining possible environmental effects of an Erwinia engineered to delete the pathogenic section from the genome. Such testing procedures are currently being used in this laboratory and will be necessary to determine the probability of environmental impact prior to the actual release of the GEM.

153

LUCIANO, JUAN Z. and CATHY HIX. Tennessee Technological University--The effects of ultraviolet radiation on Saccharomyces uvarum metabolism.

The objective of this study was to measure the effect of UV radiation on the metabolism of Saccharomyces uvarum in wort used in beer production. Pure yeast cultures were exposed to 0.18 $J/M^2/sec$ for 10, 20, 30, and 40 minutes and added to fresh wort. Cultures were allowed to ferment for 96 hours at 13° C, and fermentation products were assayed at 24-hour intervals. Metabolic parameters measured were balling, alcohol, and cell count. Percent alcohol (V/V %) increased significantly at all exposures. As the UV dosage increased, alcohol levels showed a significant decline with longer exposures. Balling levels dropped at each exposure level among samples. The ability for the yeast to metabolize sugars decreased as UV exposure was increased although pitching rates fluctuated. None of the samples showed a logarithmic growth pattern, except for the controls which did not exhibit a lag phase. All other samples decreased cell counts as exposure levels increased. Substrate availability was not a factor in the metabolism of Saccharomyces uvarum. Cell count levels at each exposure could have possibly affected the metabolic parameters because of high mortalities. The number of live cells decreased as exposure time increased. Although the availability of cells was low, metabolic rates appear to have been altered by the UV light.

154

BABBITT, MICHAEL J., DAVID E. CROWLEY, and C.P.P. REID. University of Florida--Biodegradation of ferrioxamine B, a hydroxamate siderophore.

The influence of siderophores (microbial iron chelates) on plant and microbial iron nutrition in soils is affected by siderophore production, adsorption, and degradation. Biodegradation of ferrated ferrioxamine B (FOB) was examined in the presence of a general microflora of grassland soil. Soil was added to sterile liquid media (1:400, w/w) containing FOB, after which decreased optical density indicated FOB degradation. When FOB was the only N amendment in nutrient liquid medium with glucose, significant microbial growth occurred and 30% of the FOB was degraded in 30 days. However, when FOB was the only C amendment in nutrient medium with ammonium added little microbial growth occurred but 80% of the FOB was degraded in nine days. This suggests that FOB is more readily utilized by microorganisms for C than for N. Degradation of FOB was also examined in moist soil by measuring CO2 evolution. When only FOB was added and mixed with soil, 96% of the FOB was degraded in 100 days. In comparison, degradation in soil of ferrated ethylenediaminetetraacetic acid (Fe-EDTA), a synthetic chelate, ceased after 36 days, when 73% still remained. Such evidence indicates that determinations of siderophore levels in soil will have to consider microbial catabolism of the siderophores. Supported by NSF grant BSR-8696047.

155

EDWARDS, ROBERT W., BELL, CONSTANCE A., and WEINER, TIMOTHY. University of North Carolina--Parasitic infections of migrant farmworkers in eastern North Carolina.

A sample of 371 migrant farmworker children was obtained from a migrant health center and two migrant daycare centers in eastern North Carolina during the summer of 1985. One hundred seventy-two individuals were found to be infected with one or more enteric parasites. Of this group, 98 were singly infected and 54 harbored concurrent infections of two or more species of enteric parasitic infections. Only two of the 16 parasite species recovered, Giardia lamblia (37%) and Entamoeba coli (19%), had prevalences greater than five percent. Protozoan, nematode and multiple infection prevalences vary significantly by migrant nationality. Helminthic infections and symptomatic diarrhea were found most frequently among multiply infected individuals. Migrant farmworkers and their children are at risk to various enteric parasitic infections, when compared to the

U.S. population at large, and therefore, should be considered in any public health effort directed toward parasitic infections and disease, their prevention and control.

156

FAULKNER, CHARLES T. and SHARON PATTON. Department of Anthropology and Department of Pathobiology, University of Tennessee, College of Veterinary Medicine--Analysis of paleofecal samples from Big Bone Cave, Van Buren County, Tennessee.
Paleofecal specimens (n=8) recovered from Big Bone Cave in Van Buren County, Tennessee were analyzed for parasite products with the aid of the Trend FeKal Con-Trate sedimentation technique. Radiocarbon dating of torch material (primarily Arundinaria sp.) indicated that the cave was a locus of human activity between 2500 and 2000 years ago. Human origin has been ascribed to these feces on the basis of dietary content. Although no parasite eggs were recovered on the initial examinations, the absence of this evidence is addressed with respect to the fecundity of the parasites, sample size, seasonality of deposition and the potential use of Chenopodium sp. as an anthelmintic.

157

HENDRIX, CHARLES M. Auburn University-Aberrant cerebellar myiasis due to a larval Cuterebra sp. in a kitten: a case report.
A 3 ½-month-old female domestic short haired kitten was presented to a Mississippi veterinary clinic with cutaneous myiasis on the left side of the neck. The parasite was identified as a second stage larval Cuterebra sp. Four days following larval extraction, the kitten was readmitted exhibiting these clinical signs: anorexia, adipsia, dehydration, anisocoria, blindness, left forelimb lameness, head pressing and seizures. The cat was referred to the Department of Small Animal Surgery and Medicine, College of Veterinary Medicine, Auburn University. Following data base collection, neurological examination and collection of cerebrospinal fluid, a tentative diagnosis of cerebral cuterebrosis was rendered. The kitten was treated symptomatically with steroids and was dosed with ivermectin (300 mcg/kg BW) administered on alternate days for three treatments. Following therapy the kitten's condition and neurological signs improved, and ten days following the final ivermectin treatment, the cat was euthanized. A necrotic larval dipteran was beneath the meninges over the left cerebellum. Following histopathologic examination, a final diagnosis of aberrant cerebellar cuterebrosis was rendered.

158

JOHNSON, SANDRA STRAWBRIDGE, CHARLES T. FAULKNER, SHARON PATTON and MICHAEL A. BREIDER. Department of Pathobiology, University of Tennessee, College of Veterinary Medicine--Oral efficacy evalulation of SCH 32481/G-418 (Hapadex-Schering Corporation) against the naturally occurring gastrointestinal parasites of dogs in Knoxville, TN.
SCH 32481/G-418 was highly effective against Ancylostoma caninum, Uncinaria sp. Toxocara canis, Trichuris vulpis and Taenia sp. when administered at the rate of 200 mg/kg of SCH 32481 and 10 mg/kg of G-418 once a day for 3 days. It had no noticeable effect on Dipylidium caninum. Two other dosages (SCH 200 mg/kg, 20 mg/kg G-418 S.I.D. 1 day; SCH 100 mg/kg, G-418 10 mg/kg B.I.D. 1 day) were only highly effective against Taenia sp. All dogs remained healthy and active during the study period. Untoward effects as a result of the drug were not observed at necropsy or in the BUN/creatinine analysis. Inflammatory reactions probably caused by migration of parasitic larvae were noted in the kidneys of 9 of the 12 experimental dogs.

159

ORLOFF, MICHAEL H., CHARLES T. FAULKNER, SHARON PATTON, SANDRA STRAWBRIDGE JOHNSON, and NANCY JOHNSON. Department of Pathobiology, University of Tennessee, College of Veterinary Medicine--Evidence of an anthelmintic resistant population of trichostrongyles in a dairy goat herd in northern Georgia.
The efficacy of three anthelmintics was evaluated against naturally occurring infections of nematodes in dairy goats. The study population was predominately a herd of Toggenburgs, ranging from 6 months to 8 years of age. All of the adults had grazed at the Pine Cone Valley Goat Farm for at least 6 months. The goats were divided into 3 treatment groups of 12 goats each based on the results of quantitative egg counts. Group 1 which averaged 875 eggs per gram (epg) was treated with a gel formulation of levamisole; Group 2 averaged 1241 epg and was given a paste formulation of fenbendazole; Group 3 which averaged 946 epg was treated with an injectable formulation of ivermectin. Average egg counts at post-treatment day 10 were 21, 471, and 71 indicating reduction of 97.6, 62.08, and 92.49% respectively. These figures indicate that a population of trichostrongyles resistant to fenbendazole was present on the farm.

160

BONE, LEON W., and KURT P. BOTTJER. Animal Parasite Research Laboratory, ARS, USDA -- Morphological effects of Bacillus thuringiensis israelensis on eggs and larvae of Trichostrongylus colubriformis.
Eggs and rhabditiform larvae of the ruminant parasite Trichostrongylus

colubriformis developed normally in *Caenorhabditis briggsae* Maintenance Medium. A toxin from a crystal-enriched preparation of the bacterium *Bacillus thuringiensis israelensis* was lethal to nematode eggs and larvae either initially, or after 24 hours of larval development. Treated eggs were granular and degenerative while non-treated eggs developed normally. Treatment of eggs after 24 hours for development yielded larvae that were granulated, moribund or dead, and with esophageal derangements. The ovicidal toxin from *B. t. israelensis* may allow microbial control of parasitic nematodes.

161

BLAGBURN, BYRON L.,[1] JOHN C. FRANDSEN,[2] and DAVID S. LINDSAY.[1] Auburn University[1] and Animal Parasite Research Laboratory[2] *Amprolium for control of coccidiosis in pastured pygmy goats: comparison of two regimens.*

Male and female pygmy goats, naturally infected with several species of coccidia, were given amprolium (Corid 9.6% solution) at doses of 25 and 50 mg/kg BW twice daily for 5 days (Regimen 1). Fecal oocysts were enumerated before treatment and at varying intervals after treatment. This regimen was compared to continual administration of amprolium in the drinking water at a rate of 1 pint per 100 gallons by again monitoring fecal oocyst numbers before and after treatment (Regimen 2). Nontreated control goats were maintained during both regimens. Amprolium was effective in temporarily reducing oocyst excretion in treated goats when compared to controls in regimen 1. This was followed, however, in most treated goats, by a rapid increase in fecal oocysts after drug withdrawal. Fecal oocyst numbers declined gradually in goats given amprolium continuously in drinking water until they were significantly lower than control goats approximately 10 weeks after treatment was initiated. Results indicate that periodic treatment can precipitously reduce fecal oocyst counts, but that numbers quickly rise again in the absence of retreatment. Although continual medication with amprolium requires more time to sufficiently lower oocyst numbers, this regimen may reduce, more effectively, environmental contamination with oocysts, and deserves further study.

162

PATTON, SHARON, SANDRA STRAWBRIDGE JOHNSON, JOHN NEW and MARIJANE DAVIS. Department of Pathobiology, University of Tennessee, College of Veterinary Medicine --*Serological survey for Toxoplasma antibodies in white-tailed deer of Cades Cove, Great Smoky Mountains National Park.*

Toxoplasma gondii is a ubiquitious protozoan parasite that can infect many species of mammals and birds. The disease, toxoplasmosis, is a zoonosis. Cats, both exotic and domestic, are the definitive hosts and shed oocysts in the feces. Other animals can be intermediate hosts and harbor tachyzoites and/or cysts in their tissues. In conjunction with a survey for infectious diseases in the white tailed deer of the Cades Cove area of the Great Smoky Mountains National Park, blood was collected to be screened for antibodies to *Toxoplasma*. Serum was separated from the blood samples and stored at -70 degrees C until analyzed by indirect hemagglutination. From March 1980 - February 1985, 464 serum samples from different deer were tested; 14 (3.02%) samples were positive with titers of 64 or higher.

163

SCHORR, MARK S. Mississippi State University--*Enteric Protozoans of Amphibian Larvae.*

Interspecific, ontogenetic and intersite differences in occurrence and abundance of a selected group of enteric protozoan commensals (*Opalina* sp., *Euglenamorpha hegneri* and *Nyctotherus cordiformis*) were studied in the tadpoles of following frogs: *Rana clamitans*, *Acris gryllus*, *Gastrophryne carolinensis* and *Bufo woodhousei*. Tadpoles of each species were collected from at least two sites in east-central Mississippi in 1986 and preserved in 10% formalin immediately after capture. Tadpoles were staged according to Gosner (1960). The number of protozoans from the anterior portion of the rectum were quantified (number/mm^3). The patterns of ontogenetic acquisition of the protozoans by their hosts are compared. *Opalina* sp. and *N. cordiformis* were found in each host. *Opalina sp.* was more abundant than the latter. *E. hegneri* was found in very few hosts. In most tadpoles, *Opalina sp.* was acquired at about stages 25-26 and stayed with the tadpole through metamorphosis. However, opalinids were not found until stage 30 in *B. woodhousei* and were lost at stage 46 in *R. clamitans*.

164

LINDSAY, DAVID S., BYRON L. BLAGBURN, and CHRISTINE A. SUNDERMANN. Auburn University -- *Development of Cryptosporidium baileyi in avian embryos.*

Ten-day-old embryonating eggs of the following species were infected with *C. baileyi* by inoculation of sporozoites into the allantoic cavity: chicken (*Gallus gallus*), turkey (*Meleagris gallopavo*), muscovy duck (*Cairina moschata*), Peking duck (*Anas platyrhynchos*), bobwhite quail (*Colinus virginianus*), Japanese quail (*Coturnix coturnix*), chukar partridge (*Alectoris graeca*), ring-necked pheasant (*Phasianus colchicus*), and guinea fowl (*Numida meleagris*). Development from sporozoite to sporulated oocyst occurred in the microvillous border of the endoderm of the chorioallantoic membrane of all species of avian embryos examined. None of the embryos died from experimental infection with C. baileyi. Serial passage of C. baileyi from chicken embryo to chicken embryo was achieved by inoculation of oocysts obtained from previously infected chicken embryos.

165

LAU, ROBYNE R. and DONALD R. YOUNG. Virginia Commonwealth University--The effect of integration on the water relations and survivorship of a clonal understory herb.

Field and greenhouse studies were conducted to determine the effect of physiological integration on the water relations and survivorship of the clonal understory herb, Lycopodium complanatum. Greenhouse experiments showed that water was translocated from shaded ramets to sunlit ramets causing an increase in the xylem pressure potentials of the latter, relative to severed sunlit ramets (-0.8 ± 0.7 MPa vs -2.4 ± 0.3 MPa). Pressure volume analyses indicated that water storage (ie. capacitance) for the genets occurred in the ramet crowns and in the roots. In severing experiments, daily and seasonal field measurements revealed a trend toward higher xylem pressure potentials in connected versus severed ramets, -2.0 ± 0.1 MPa and -2.8 ± 0.4 MPa, respectively. Further, survivorship studies indicated that mortality was 50% higher in severed ramets when compared to connected ramets, with severed ramets in open microsites showing a trend toward higher mortality than those in more shaded microhabitats. The results provide evidence that clonal growth in L. complanatum may be an adaptation that enhances water status in the heterogeneous light environment of the forest understory.

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BROYLES, STEVEN B. and ROBERT WYATT. University of Georgia--Floral displays and reproduction in Poke Milkweed (Asclepias exaltata L.).

In milkweeds (Asclepias) many flowers fail to mature into fruits. The pollen donor hypothesis suggests that a large floral display is an adaptation to increase male, rather than female, reproductive success. We investigated the effects of umbel size (5, 10, 15 and 20 flowers), number of flowers per stem (30 vs. 60), and number of umbels per stem (3 vs. 6) on male and female reproductive success in Asclepias exaltata. The numbers of pollinaria removed, fruits initiated, and fruits matured increased with increase in umbel size. Rates of pollinaria removal and fruit initiation per flower increased with umbel size, but rate of fruit maturation decreased. Stems with 60 flowers experienced a two-fold increase in pollinaria removal, fruit initiation, and fruit maturation. For constant flower number per stem, an additional increase in reproductive success was observed for stems with 6, versus 3, umbels. Fruit abortion is more common in umbels that initiate a larger than average number of fruits (1.37 ± 0.62). Furthermore, fruits maturing in these umbels contained more seeds than did fruits maturing in umbels in which there was no fruit abortion. Thus, larger floral displays of Asclepias exaltata. not only dispersed more pollen, but also initiated more fruits and matured fruits with more seeds.

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HARKER, ANNE C., CORY W. BERISH, and HARVEY L. RAGSDALE. Emory University--Root dynamics in relation to ecosystem nitrogen and root litter quality in early successional forests of the southern Appalachians.

Root dynamics were studied in two 19-yr-old forest stands (one dominated by black locust, the other a pine-hardwood mixture) having a similar aspect (NW) and soil type (typic Hapludults). Higher soil nitrate concentrations, N-mineralization, and nitrification rates are associated with the area dominated by the N-fixing tree black locust. We hypothesized that higher soil nitrogen availability should increase root decomposition rates which are potentially limited by C:N ratios. Nylon mesh bags containing freshly air-dried root tissue (5mm diameter) were placed in the A1 soil horizon in each site. Mass, nutrient (e.g. N, C, K, Mg, Ca), soluble carbohydrate, and lignin losses were monitored for two years. Tulip poplar, black locust, and blackberry root tissue lost 61, 58, and 95% of their original dry mass following two years of field incubation in the black locust stand. Dry mass losses for the pine-mixed hardwood stand were 68, 52, and 62% for tulip poplar, mountain laurel, and pitch pine root tissue. Analysis of the major variables suggests that fine root decomposition rates in the southern Appalachians are influenced more by initial lignin concentrations than either soil nitrogen availability or fine root tissue nitrogen concentrations.

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HUMPHREY, L. DAVID. Georgia Department of Natural Resources, Game and Fish Division, Protected Plant Program --Population trends of Baptisia arachnifera in pine plantations.

Baptisia arachnifera, an herbaceous perennial in the Fabaceae, is federally listed as endangered. The Georgia Protected Plant Program has begun monitoring to provide information necessary for management and protection of this species. Plants were censused on six 50 x 50 m plots, each in a pine plantation of a different age (one to 23 years). Population structure was analyzed based on classification of plants as seedling (unbranched), juvenile (branched) or mature (flowering) and on diameter of the perennial root crown. Substantial recruitment of young plants (seedling class with root crown diameter ≤ 1.0 cm) occurred on all plots except the 23 year old stand. In the older plantations fewer older plants (root crown diameter > 2.0 cm) produced flowers and fruit than in the younger plantations. This indicates that the populations are suppressed or declining. Fewer plants with root crown diameters > 2.0 cm produced flowers in the one year old plantation as well. This may be a result of stress from site preparation and replanting. Also in the one year old plantation, the number of juvenile plants was greater than on other plots. Many appeared to be root sprouts. Based on our preliminary results, many *B. arachnifera* plants survive pine harvesting and replanting but with a reduction in fruit production and no increased recruitment. Fruit production increases after a few years but declines in older plantations as the population declines.

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WARD, DEANNA M. and W. DEAN COCKING. James Madison University--*DECORANA ordination of herb and shrub layers in mesic forest stands along Skyline Drive in Shenandoah National Park, VA.*
Relative cover estimates of 223 herb and shrub layer species occurring within 60 mesic forest stands in Shenandoah National Park, VA, were compared to each other on the basis of similarity, and used to construct DECORANA ordinations. An ordination of all sites strongly segregated the stands by successional age along the x-axis. Correlations with site characteristics emerged when two ordinations were constructed using only the old (> 60 yr.) and young (< 60 yr.) stands separately. Elevation was a major factor correlated with the first axis for both age classes. Because of geologic layering correlated with elevation, distribution on Pedlar and Catoctin soil parent materials also correlated with this axis. Many herb and shrub species were strongly associated with each soil type. Herbs growing on the more fertile Catoctin soils include: *Laportea canadense*, *Trillium grandiflorum*, and *Cyripedium calceolus*. *Kalmia latifolia*, *Vaccinium* spp. and *Rhododendron* spp. were associated with the less fertile Pedlar soils. Slope exposure and soil pH, moisture, and temperature also affected stand positions within the ordination. The presence of some widespread species such as *Viola triloba* and *Parthenocissus quinquefolia*, was not strongly affected by these environmental factors. Patterns within the herb and shrub ordination are similar to those reported previously for canopy tree ordinations of these same stands.

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FAIREY, JOHN E. III[1], K.M. PETERSON[1], and LOYD G. WEBB[2]. Clemson University[1], L.G. Webb Associates, Clemson S.C.[2]--*Vegetational changes associated with land application of industrial wastewater near Martin, S.C.*
Proponents of land application of municipal and industrial wastewater point to the fact that soil microorganisms act as a living filter, decomposing many of the organic constituents which might otherwise enter rivers directly. This study was conducted to document effects of such application on vegetation owned by Sandoz Inc. near Martin, S.C. Wastewater from the chemical production of commercial dyes and insecticides has been sprayed on an established *Pinus elliotii* plantation since April, 1979. Vegetational composition has been followed by measuring treated and control plots twice annually since 1979. The initial impact of the spray was to eliminate associated hardwoods, primarily *Quercus laurifolia*. Other species, notably *Opuntia compressa*, and *Passiflora incarnata*, after showing an initial deleterious reaction, appeared to rebound and grow vigorously. Beginning in 1982 an assemblage of weedy species including *Ambrosia artemisiifolia*, *Baccharis halimifolia*, *Chenopodium album*, *C. ambrosiodes*, *Cynodon dactylon*, *Elusine indica*, *Echinochloa crusgalli*, and *Lepidium virginianum*, dominated the sprayed area. Persistence of this weedy flora may be due to salt tolerance.

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KELLY, ROBERT C. and R. R. SHARITZ. Univ. of Georgia Savannah River Ecology Laboratory--*Settlement-era composition of floodplain and upland forests determined using colonial land surveys.*
Colonial and post-revolutionary (1730-1830s) land survey plats were reconstructed as a data base to characterize the composition of settlement-era forests along the Savannah River. The 120-square mile study area was located just below the Fall Line between Piedmont and Upper Coastal Plain physiographic provinces. It was divided into floodplain and upland regions, and further subdivided to represent a floodplain gradient from least frequently (Area 1) to most frequently (Area 4) flooded conditions. Copies of original plats were superimposed onto USGS quadrangle maps and forest composition was determined by recording the frequency of occurrence of tree genera as recorded along survey lines. The genera whose frequencies varied the most across the floodplain gradient were beech (from 21% in Area 2 to 0% in Area 4) and cypress and tupelo (from 1.3% in Area 1 to 24% in Area 4). Oak genera were the most commonly recorded trees for all four areas (26-38%). A diverse forest of 37 different tree genera, including sweetgum, black gum, hickory, mulberry, elm, ash, maple, holly and sycamore, was noted on surveys through floodplain areas. Fourteen genera (predominantly

pine(46%), oak (35%), and hickory (14%)) were reocorded in adjacent upland surveys. This preliminary study demonstrates that "metes-and-bounds" type surveys, the only records available for lands settled during the Colonial period, can be used as a source of data to distinguish historical patterns of forest composition across environmental gradients.

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KNOX, ROBERT G. and ROBERT K. PEET. University of North Carolina -- Comparing vegetation data sets with bootstrapped ordination.

Up to now, there has been no technique available to directly compare the patterns of species association in different vegetation data sets. We developed a new, computer-intensive, approach to estimate sampling effects on ordination solutions. We then used this estimate of sampling error to assess differences between patterns of species association in three data sets. Tree and herb data from a set of 0.1 ha plots in the North Carolina Piedmont produced statistically indistinguishable patterns. In contrast, "indirect gradients" were demonstrably different across plots sampled near Mt. Mitchell in the southern Appalachians. The method also shows promise for testing change in vegetation over time, assessing the stability of ordination solutions, and comparing ordination techniques.

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BYRNE, STEPHEN V. and THOMAS R. WENTWORTH. North Carolina State University--Relationship between volume and biomass of early successional vegetation and the prediction of loblolly pine seedling growth.

Aboveground biomass is frequently used as an estimate of the competitive potential of early successional vegetation in southern pine plantations. Because direct biomass measurements are destructive and highly labor-intensive, we developed an alternative estimate of competitive potential based on aboveground volume (space) occupied by successional plants. The relationships between plant volume and biomass (oven dry basis) were determined for each of four growth forms (grasses, forbs, shrubs, trees), based on data from 40 1-m^2 plots located in an experimental loblolly pine (Pinus taeda L.) plantation. Varying amounts of successional regrowth had been established and maintained in the plantation through the use of two site preparation techniques and three levels of cultural practice. Variation in plant biomass explained by regressions of biomass on volume ranged from 78% for grasses to 94% for trees. The regression equations for woody growth forms (shrubs and trees) versus non-woody growth forms (grasses and forbs) and for shrubs versus trees were significantly different. Aboveground volume of all successional plants within a 2m radius of experimental pine seedlings explained approximately 40% of the variation in the seedlings' growth.

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MCLEOD, DON E. MARS HILL COLLEGE --Vegetation patterns and environmental factors in the Black and Craggy Mountains, N.C.

As a part of a floristic and vegetation study of the Black and Craggy Mountains of North Carolina, I sampled the vascular plants with an estimation of cover-abundance in 156 0.1 ha plots. Multivariate analysis techniques were used to classify and ordinate this data set and to correlate vegetation with environmental factors. Seventeen vegetation types were recognized: cove forest, alluvial forest, eastern hemlock-mesic forest, eastern hemlock forest, white oak forest, oak-yellow poplar forest, red oak-chestnut oak forest, red oak forest, chestnut oak forest, scarlet oak forest, Carolina hemlock forest, xeric oak-pine forest, beech-yellow birch forest, spruce forest, fir forest, heath balds and meadows. The primary ordination shows strong correlation of the vegetation with elevation on the vertical axis, solar beam irradiation on the horizontal axis, and soil nutrients as a diagonal gradient. Subsequent ordinations reveal strong correlations of the vegetation below 1524 m (5000 ft) with soil nutrients, aspect, slope position, slope degree, solar irradiation and elevation. Correlations above 1524 m were strongest with pH, P, elevation, solar irradiation and aspect. These results indicate that the composition of the vegetation of the area can be satisfactorily correlated with environmental variables, especially elevation, soil nutrients, pH and solar irradiation. Furthermore, sampling all vascular plants leads to better results than sampling only arborescent vegetation.

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HAWKINS, MIKE,[1] LYNNE BURTON,[1] DANA GRANTHAM,[1] WILLIAM MARTIN,[2] C. B. COBURN.[1] Tennessee Technological University[1] and Eastern Kentucky University[2]--- Survey of woody flora on the north-facing slope in Savage Gulf Natural Area. Number 1.

The Savage Gulf forest is a virgin forest of high diversity located in the southern section of the Mixed Mesophytic Forest Region and includes some rare plant species. This is the first of a long term study to determine stability or changes of forest communities on the north-facing and south-facing slopes of Savage Gulf. Limited community analysis and the floristic composition of nine plots using the tenth hectare method are reported in this paper. No particular tree dominates the canopy in the majority of the plots. However, a core group of canopy species was dominant in the majority of the plots. These included *Tilia heterophylla*, *Liriodendron tulipifera*, *Acer saccharum*, *Aesculus octandra*. The sub-canopy contained the least diversity and number of individuals and had no demonstrated dominance. The understury was the most diverse as well as the most populous layer. In the understory, *Acer saccharum* was predominant. Other prominent understory shrubs were *Lindera benzoin*, *Viburnum acerifolium*, *Asimina triloba*, and *Hydrangea arborescens*.

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MCCORMICK, J. FRANK, University of Tennessee -- *Ecological implications of the Chernobyl accident*.

Scale is the most significant aspect of the Chernobyl accident; geographical scale of impact, scale of radioactivity released, scale of response to the disaster, and scale of research opportunities. Over 50 x 10^6 curies of radioactivity were released into our global environment, and this was only 3.5% of the total in the reactor at the time. Radionuclides of greatest concern are I^{131} and Cs^{137}. Approximately one-half of the total was deposited in a 1600 sq. mile zone of quarantine. Within this zone, radiation exposures as high as 10 Rad/hr were experienced for several days, or even weeks. These exposures were sufficient to produce significant ecological effects within a few hours. Although U.S. ecologists have had only limited opportunities to participate in global assessments of the accident, a great deal has already been learned. For example, ecologists at Oak Ridge National Laboratory discovered that pre-existing models over predict, by a factor of 15X, levels of radionuclide transport in the air-vegetation-cow-milk-man food chain. They also found that bioaccumulation of I^{131} is insignificant in this food chain. The enormous scale of the Chernobyl accident provides unprecedented opportunities for long term research on radionuclide transport and ecological effects of ionizing radiations.

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PARTON, ELAINE E. Louisiana State University Coastal Ecology Institute--*Effects of herbivory on vegetation on delta islands in Atchafalaya Bay, Louisiana*.
Deltaic islands in Atchafalaya Bay, Louisiana support large marshes dominated by *Sagittaria latifolia* and *S. platyphylla*. Grazing by herbivores may have a marked effect on th vegetation in these developing marshes. To test this hypothesis, exclosures were erected on the islands in September, 1985. Treatments included a control area and areas excluding furbearers and waterfowl, furbearers only, and waterfowl only in each site. Results of the experiment in the first year, based on vegetation field sampling and mapping from aerial photography, indicate large differences in plant biomass and species composition between treatments

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VISSER, JENNEKE M. Louisiana State University--*Productivity of two Sagittaria species in a developing delta, Atchafalaya Bay, Louisiana*.

Sagittaria latifolia and *Sagittaria platyphylla* are the dominant vascular plant species on islands in the new delta developing at the mouth of Wax Lake Outlet in Atchafalaya Bay, Louisiana. These plant species provide important habitat for large numbers of waterfowl and furbearers. Above ground productivity was measured during the 1986 growing season by non-destructive sampling at three week intervals. Leaf length and stem density were measured, and biomass determined from an experimentally derived relationship between leaf length and density and biomass. Belowground productivity was estimated from root and tuber biomass in cores taken at six week intervals over the same growing season.

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WAGNER, LISA K. Georgia Southern College. --*Reproductive effort in Poa annua*.
Reproductive effort (RE - the proportion of total biomass allocated to reproduction) can vary greatly among species, reflecting a variety of factors including life history and habitat. There has been considerable recent interest in size-dependent variation in plant reproductive effort. In this study, I investigated components of RE in relation to plant size in two populations of *Poa*

annua, a widely-distributed weedy annual common in disturbed habitats. Reproductive phenology, allocation patterns, and reproductive output were determined for two successive seasons.

Mean RE in the two populations was 18% and 27% in the first season of study and 34% and 33% in the second season. Reproductive weight showed a strong linear relationship to total vegetative weight with highly significant R^2 values, indicating most of the variation in absolute reproductive allocation can be explained by variation in plant size. RE, however, was relatively constant over all size classes.

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HULL, JAMES C. Towson State University--*Comparative nitrogen economy of four California annual grasses.*

The responses of four California annual grass species (*Avena fatua*, *Lolium multiflorum*, *Bromus diandrus* and *B. mollis*) to applications of available nitrogen in laboratory and field experiments is described. Nitrogen use efficiencies as measured by photosynthetic rates per unit leaf nitrogen are compared between laboratory and field grown samples. All species have similar slopes of photosynthesis versus tissue nitrogen contents, however, for *B. mollis* photosynthetic rates per unit nitrogen are significantly lower than the other species. Field measurements corroborate laboratory measurements. *Lolium multiflorum* and *B. mollis* have significantly greater relative growth rates at low and high availabilities of available nitrogen. The factor most closely associated with the high relative growth rate is the significantly greater nitrogen assimilation rate per unit weight of root.

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SCHMALZER, PAUL A., MARK J. PROVANCHA, AND C. ROSS HINKLE. The Bionetics Corporation and the National Aeronautics and Space Administration--*Vegetation mapping of John F. Kennedy Space Center, Merritt Island, Florida.*

Vegetation of the 56000 ha barrier island complex included within John F. Kennedy Space Center on the east coast of central Florida was mapped at a scale of 1:9600 using low altitude, color infrared imagery. Maps were digitized at a pixel resolution of 0.051 ha. Composite maps were also prepared in topographic quadrangle format (1:24000) along with a single map for the entire center (1:50000). Thirty-two plant communities and 9 classes of land use or bodies of water were identified and mapped. Major vegetation types included: coastal dunes, coastal strand, coastal live oak woods, sand pine, mixed oak-saw palmetto scrub, slash pine flatwoods, hammocks (several types), willow and hardwood swamps, cabbage palm savanna, mixed graminoid marshes, cattail marshes, salt marshes, mangroves, vegetation of disturbed sites, and citrus groves. Ground reconnaissance and helicopter transects were used to verify boundaries. Quantitative data from 417 vegetation sample plots were used to determine map accuracy. These maps form part of a Geographic Information System to be used in land use planning and management.

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THOMAS, RONALD L. and W. DEAN COCKING. James Madison University--*Increased mercury bioaccumulation in plants growing on experimentally acidified soil.*

Previous studies by our terrestrial ecosystem mercury research group have demonstrated significant mercury bioaccumulation by vegetation growing on contaminated floodplain soils at Waynesburo, VA. In this study, significantly greater mercury accumulation was observed in potted old-field plants grown from seed in experimentally acidified mercury contaminated soil (30-40ppm) than in plants from soil of greater pH. Soil with pH 5.2-6.0 was collected from the field at Waynesboro and acidified with elemental sulfur to pH 4.3-4.7, neutralized with field grade lime to pH 7.0-7.5, or left untreated as a control. *Allium canadense*, *Asclepias syriaca*, *Daucus carota*, and *Oenethera perennis* were each grown in 10, 15cm pots containing soils with the three pHs. They were also grown in 10 pots of soil containing <1ppm mercury. Roots and shoots were harvested, acid washed, dried and ground. Following wet acid digestion, samples were analyzed for total mercury with atomic absorption spectrophotometry. Roots of all species from acidified soil accumulated significantly more mercury than those from neutralized soils. Means for *A. canadense* root tissue mercury from acid, control, and neutral soils were 7.03ppm, 5.05ppm, and 3.24ppm respectively. *A. syriaca* root mercury was 0.75ppm, 0.74ppm, and 0.22ppm in acid, control, and neutral soils. Root tissue of all plants growing in low mercury soil had undetectable mercury concentrations except *A. canadense* which contained 0.13ppm. Shoot mercury content also tended to be greater in plants from acidified soils, but was variable. Since soil pH may be subject to lowering by various environmental factors, ecosystems that exhibit only moderate mercury bioaccumulation at or near neutral pHs may require reevaluation if soil pH decreases.

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BASKIN, JERRY M.,[1] CAROL C. BASKIN,[1] and J. FRANK MCCORMICK.[2] Univ. of Kentucky[1] and Univ. of Tennessee[2]--Seasonal changes in the germination responses of buried seeds of the granite outcrop summer annual endemic Portulaca smallii.

Portulaca smallii P. Wilson is a succulent summer annual endemic to granite outcrops of the Piedmont of Virginia, North Carolina and Georgia. Seeds were buried from 0 to 28.5 months in pots of outcrop soil and exposed to natural seasonal temperature changes. On the first day of each month, seeds were exhumed and tested in a 14-h daily photoperiod and in darkness at (12/12 h) daily thermoperiods of 15/6, 20/10, 25/15, 30/15 and 35/20 C. Seeds were dormant at maturity in mid October 1981, but they became completely nondormant by May 1982. Nondormant seeds required light for germination, but even in light they did not germinate at 15/6 C. After seeds lost their initial dormancy, they retained the capacity to germinate to 65-100% in light at 35/20 and 30/15 C throughout the remainder of the study, which ended in March 1984. In September 1982 and September and October 1983, germination at 25/15 declined to 38, 19 and 35%, respectively, but by November and December seeds had regained the ability to germinate to 73-98%. Seeds germinated at 20/10 C only from April - July 1982 and from February - April 1983. The species belongs to the category of summer annuals in which the buried seeds do not re-enter dormancy in spring. Thus, seeds potentially can germinate throughout much of the growing season.

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POTTER, CHRISTOPHER S. and HARVEY L. RAGSDALE. Emory University--Changes in foliar nutrient resorption during southern Appalachian forest regeneration conflict with Odum's ecosystem theory of successional nutrient cycling dynamics.

Odum hypothesized that nutrient cycling patterns are open early in succession and close with ecosystem development toward maturity. To test this hypothesis, leaves were sampled over a growing season in a successional, southern Appalachian forest to estimate foliar nutrient resorption. We predicted that if nutrient cycles become increasingly closed during forest succession, plants should shift their nutrient allocation from lower to higher levels of resorption as stands approach maturity. We found that autumn resorption of N and P in a successional forest was equal to, or exceeded, resorption estimates for a more mature control forest. Foliar nutrient leaching was not sufficient to account for changes in autumn leaf N, P, Ca and Mg concentrations. Nutrients cycles close early in southern Appalachian forest regeneration, due in part to resorption, which conserves nutrients by reducing element losses from leaching and litterfall. We hypothesize that rapid recovery of net primary productivity early in forest regeneration is the result of maximum nutrient resorption of limiting elements. Implications for successional nutrient cycling theory are discussed.

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LEITMAN, HELEN M. U.S. Geological Survey, Tallahassee, Florida--Relation of tree communities to the duration of inundation on the Apalachicola River flood plain, Florida.

The relation of plant species to hydrologic conditions in flood plains is a complex environmental process of considerable interest to scientists and regulatory agencies. Plant species are being used to define wetland areas for regulatory purposes by State and Federal agencies. Because the extent and duration of flooding is the key physical feature of wetland areas, it is important to accurately document the relation of plants to hydrologic conditions. Wetland hydrology and tree communities of the Apalachicola River flood plain, Florida, were studied to determine the percentage of time over a long period of record that water inundated the areas where the 5 most important tree communities occurred. Continuous stage records for 1-½ years in the flood plain and 22 years in the river channel were used to estimate the duration of long-term inundation in the flood plain. Occurrence of tree communities was highly related to periods of inundation. Median periods of inundation ranged from 8 to 22 percent for 2 bottomland hardwood communities and from 53 to 89 percent for 3 tupelo-cypress communities.

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VAN HORN, GENE S. and LARRY G. WILLIAMS. University of Tennessee at Chattanooga--A floristic survey of Chilhowee and Bean Mountains in Polk Co., TN

Vascular plants were collected and identified from the Chilhowee-Bean Mountain area of over 10,000 ha through a period of 8 years. The area is repeatedly clear-cut and lacks unique vegetational sites. Elevation ranges from 232 m to 918 m. The flora contains 109 families, 379 genera, and 743 species. Introduced species constitute 14% of the flora. A few county records and range extensions occur. Most of the area is dominated by mixed deciduous forest, but pine dominates the dry ridges and more xeric slopes. The study site is in the Ridge and Valley Province of Tennessee and has a flora that is expected for its location.

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ATKINSON, ROBERT B. Christchurch School--Establishment of a marine science program at the secondary level.

Christchurch School, an independent boarding school on the Rappahannock

River near the main stem of the Chesapeake Bay, began receiving external funding for the establishment of a marine science program in 1986. The methodolgy was to include challenging coursework with considerable field research to demonstrate how and why the effort to restore the bay is being made. Coursework included the function and importance of wetlands, water chemistry, circulation dynamics, marine geology, physiology, taxonomy, ecology and resource management as applied to the Chesapeake Bay. Field work significance was enhanced through cooperative research agreements made with the Virginia Institute of Marine Science, which requested water chemical analyses of the Piankatank River. Cooperative agreements were also made to send floristic data to the Virginia Natural Heritage Program of the Nature Conservancy. The impact of the cooperative research on student enthusiasm was significant and also improved the classroom lectures. The program has been included in the summer curriculum in 1987 and in the regular session of the school year.

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HALDEMAN, JANICE H. Erskine College--*A Model System for Demonstrating In Vitro Plant Propagation: Cauliflower.*

Pieces of cauliflower (*Brassica oleracea*) are sterilized and aseptically cultured on an agar based medium. The phytohormones kinetin and indole acetic acid contained in the medium induce rapid shoot proliferation by devernalizing the floral buds. The shoots are then separated and rooted in hormone free medium. The plantlets can be transplanted to siol. The *in vitro* procedure can be completed in five weeks, and requires only basic laboratory equipment and chemicals. The exercise illustrates quickly plant propagation by a tissue culture technique. Additional experiments that vary media and/or growing conditions can be designed once basic procedures are learned. The cauliflower is an ideal source of plant material for introducing techniques of plant tissue culture.

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PERRY, JAMES W. and DAVID MORTON. Frostburg State College--*So you want to write a book?*

Over the past 3 years we have written a laboratory manual to accompany a major biology text. As neophytes we have suffered from our naivete. The primary concern of the publisher is the company. Consequently, be wary of predictions for tremendous profits. Since publishers see success in these terms, money is used as a motivational tool to spur authors on. Read contracts carefully. These typically specify deadlines for manuscript submission, length, content, copyrights, author responsibilities, and royalities. Royalties may be a flat 10% of wholesale price of the work, or they may vary with the number of copies sold. Illustrations may be the sole responsibility of the author or their cost may be shared by author and publisher. Original artwork is extremely expensive. Photographs may be gratis from colleagues or may cost up to $200 each for half tones. Once the author has demonstrated good faith by submitting samples or portions of the manuscript, advances on royalties are a reasonable request since they not only provide financial aid for materials but also demonstrate the degree of committment the publisher has for the work. If the educational institution allows, release time should be requested. Writing a text while maintaining a full workload of teaching, graduate student guidance, research, and committee assignments is too much to expect of one's mental health, not to mention maintenance of the rudiments of familial harmony.

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SWAB, JANICE COFFEY. Saint Mary's College--*Botanical Education in Chinese Universities.*

This report is based on teaching experience at the Teachers University of Inner Mongolia, Huhehoate, capital of the Inner Mongolia Autonomous Region, People's Republic of China, during the fall semester, 1986. This one-year botany course, taught from a strictly systematics approach, is highly structured. The students use textbooks with line drawings to illustrate life cycles and organisms. A natural classification system is adhered to with evolutionary relationships emphasized. No creationism movement in this country! As the lecturer in the General Botany course, taught to second-year students, it was possible to gain insight into the planned curriculum for biology majors. Laboratory activities were also observed. Some comparisons between Teachers Universities are possible as a result of visits to several institutions. Lecturing, student evaluations, classroom dynamics, teaching schedules, and job placement are some of the topics to be discussed in this presentation.

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WINSTEAD, JOE E. and ALAN W. REED. Western Kentucky University, and Lindsey Wilson College--*Aluminum toxicity on the isopod Caecidotea forbesi (Williams) in relation to leaf litter of Carpinus caroliniana Walt and acidic environments.*

In testing the understory tree *Carpinus caroliniana* (ironwood) for release of aluminum from leaves it was found by atomic absorption analysis that more Al (0.341 mg/l) was released from 1 gm of dried leaf material under acidic conditions (pH 4.7) than under less acidic pH of 6.1 (0.153 mg/l Al). Innoculation of leaching tests with limestone retarded Al release indicating buffering capacity of Mississippian bedrock when exposed to acidic precipitation.

Exposure of isopods to 1 ppm Al was lethal at pH of 4.1 but fewer fatalities occurred at that concentration of Al and pH when limestone chips were added to the test environment (22 C). Exposure to ironwood leaf litter under both pH 4.1 and pH 4.1 innoculated with limestone was equally lethal. Exposure to 1 ppm Al and four pH conditions (3.0, 3.4, 4.1 and 4.1 innoculated with limestone chips) had no effect when the test was maintained at 8 C. Mortality was 100% after 8 days however at 8 C when the isopods were placed in a pH of 4.1 innoculated with ironwood leaves. This indicates the consumption of leaf detritus containing Al could significantly regulate populations of Caecidotea forbesi.

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HARMON, JEFF L. and JAMES E. JOY. Marshall University--Distribution, density, and biomass studies on the freshwater mussel, *Anodonta imbecillis* (Unionidae), from the McClintic Wildlife Station, Mason County, West Virginia.

Distribution, density and biomass studies of the freshwater mussel, *Anodonta imbecillis* (Say), were conducted during the spring of 1986 at the McClintic Wildlife Station in Mason County, West Virginia. Thirty-five ponds are located within the station, but only six have been found to support freshwater mussel populations. Population density for populated ponds ranged from 4.8 to 26.0 mussels per square meter, as determined by five random square meter samples employed at each pond. Mussel biomass, based on live wet weight, ranged from 125.6 to 518.4 grams per square meter. Mean individual wet weight by pond ranged from 16.4 to 29.1 grams. There was an inverse relationship between wet weight and density. Shell length frequencies were analyzed to determine approximate age distribution in each populated pond. Four of the six ponds were dominated by mussels in the 70 to 79.9 mm length class while one pond was dominated by the 60 to 69.9 mm length class, and another by the 80 to 89.9 length class.

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LASALLE, MARK W. and T. DALE BISHOP. Self-Employed and University of Georgia--Gut content analysis of larval Diptera (Dolichopodidae) from a Mississippi brackish water marsh.

The gut contents of larvae of two species of Diptera (Dolichopodidae), collected from organic-rich mud in a Juncus roemerianus marsh, were studied. Both species are predaceous, feeding primarily on oligochaetes (40-60%) and nematodes (30-40%). Average number of oligochaetes per gut ranged from 0.7 to 0.9, while average number of nematodes ranged from 0.5 to 0.7. Gut contents of each of the three larval instars of both species were similar in terms of percent composition of prey. Using mean gut content values and monthly estimates of larval Diptera density in the marsh, estimates of the quantity of oligochaetes and nematodes removed by both species were obtained. Species A removed up to 200 oligochaetes and 200 nematodes per m^2, while species B removed up to 60 oligochaetes and 30 nematodes per m^2. These larval flies may be important contributors to energy flow within the benthos of the marsh. They may also serve an important role in energy transfer between adjacent systems through predation by other consumers and adult emergence.

194

SCHMIDT, DENISE A. and DONALD C. TARTER. Marshall University--Ecological life history of the stonefly Acroneuria carolinensis (Banks) in a West Virginia stream.

The ecological life history of the stonefly Acroneuria carolinensis was studied in Panther Creek, Nicholas County, West Virginia. Length-frequency distribution indicated a two-year life cycle. The largest naiads (26.0 mm) were collected in February, April and May. Females and males exhibited greatest growth in August (28%) and October (21%), respectively. Naiads underwent 25 instars. Naiads were carnivorous in their feeding habits. Plecopterans (%FO = 15.9) and ephemeropterans (%FO = 12.5) made up the principle components of the diet. Dipterans were important components in the winter and summer, while trichopterans became important in the summer. A phoretic relationship between A. carolinensis naiads and a chironomid midge was observed on 3.7% of the naiads examined. Emergence was between 1 June and 16 June; peak emergence occurred on 8 June 1984. In the laboratory, emergence occurred between 9:30 p.m. and 1:45 a.m. Direct egg counts for adult females ranged from 10 to 800 eggs ($\bar{X}$ = 239) per female. There was little correlation between body length and number of eggs (r = 0.56). Mean egg length was 0.43 mm (range 0.38-0.48) and mean egg diameter was 0.33 mm (range 0.29-0.38).

195

MEADOWS, JAMES A. and DONALD C. TARTER. Marshall University--Benthic macroinvertebrate community structure and physicochemical conditions in the Cranberry River, Nicholas County, West Virginia.

A year long investigation of the Cranberry River, Nicholas County, West Virginia, an undisturbed watershed, was conducted to determine the environmental conditions and the benthic macroinvertebrate community composition and structure. Factors responsible for distribution and abundance of the benthos were also examined. The distribution of the functional components of the benthic macroinvertebrate community was discussed in relation to the River Continuum Concept. The benthic macroinvertebrate community was comparatively diverse but more sparsely populated relative to other nearby watersheds. Newman-Keul's pairwise comparison tests showed significant differences between the station farthest upstream and the remainder of the watershed studied. In addition, selected tributaries were shown to have significantly lower chemical water quality than the mainstream, and yet also shown to support more diverse and abundant benthic populations. Benthic macroinvertebrate density, relative abundance, and diversity and the chemical water quality decline as flow increases. Benthic population numbers were inferred to be limited by the chemical water quality. But, the benthic community appeared to be structured by physical habitat conditions related to stream flow.

196

RICHARDSON, JOSEPH P. Savannah State College--Effects of sedimentation, grazing and predation on development of a subtidal jetty community.

Radio Island jetty inside Beaufort Inlet, NC, supports a relatively rich macroalgal flora. To determine the effects of grazers and predators on subtidai community development, vertical and horizontal artificial substrata within complete, partial and no cages were submerged to 1.5m below MLW and subsequently sampled after 12 weeks and 19 weeks. On vertical surfaces, animals dominated space: bivalves and serpulid worms in complete cages; and barnacles on unenclosed surfaces. On vertical surfaces, filamentous algal coverage was not affected by caging; but coverage by foliose algae - Dictyota dichotoma, Hypnea musciformis and Padina vickersiae - was greater on unenclosed surfaces. On enclosed horizontal surfaces, animals and particularly mucous/sand tube-building polychaetes dominated space. On unenclosed horizontal surfaces, foliose algae and a turf of Polysiphonia tepida dominated space. The abundance of benthic algae on this jetty thus appears to be the result of sedimentation restricting the development of some animals and predation restricting the potential horizontal space dominants (polychaetes). Predation appears to be more important in allowing macroalgal development than is grazing in reducing macroalgae.

197

NELSON, CHARLES H. University of Tennessee-Chattanooga--Emergence Patterns and Stonefly diversity in a Great Smoky Mountain river drainage system in Tennessee.

Forty-seven species were collected along an 878 meter altitudinal gradient involving the Ramsay Prong, Porter's Creek, and the Little Pigeon River from September 1977 to August 1978. Adults occurred during each month of the year, but most species were collected from April through June at stream temperatures between 2-15°C. Spatial (altitudinal) and temporal separation as well as overlap between congeneric species is examined. A comparison with other surveys is undertaken to investigate a diversity gradient for Plecoptera in North America.

198

BARROCIERE, LEO J., C. B. COBURN. Tennessee Technological University--The ecological assessment and distribution status of the Nashville crayfish, Orconectes shoupi.

On January 12, 1977 the Federal Register summarized the status of Orconectes shoupi and proposed it as an "endangered" species. This study was initiated to update the survival status of the species and addresses the description and taxonomy, historical distribution, present distribution, and habitat requirements of the Nashville crayfish. The Nashville is an opportunistic feeder restricted to living under large flat rocks in the broader reaches of Mill Creek in Davidson and Williamson Counties, Tennessee. Only 25 percent of the stream provides suitable habitat for the species. Thus the species is potentially threatedned from siltation, stream alterations, and general water quality deterioration resulting from increased urbanization. The limited distribution of the species also makes it vulnerable to single catastrophic events, such as a toxic chemical spill, which could render the species extinct.

199

O'Bara, Christopher J. Tennessee Technological University, Cookeville, TN--Utilizing fish community structure to evaluate lotic integrity.

Recent interest in using fish community structure as an indicator of lotic integrity has lead to the development of the index of biotic integrity (IBI). In order to accurately and confidently utilize the IBI methodology, zoogeographic and physical considerations must be employed when setting scoring criteria for the 12 components of the IBI system. Field surveys of 13 major drainage basins in Tennessee and Kentucky have been conducted to aid in setting these criteria. The complexity of the fish community varied along a stream size, elevation, and geologic gradient. Communities were most complex in Mississippi River tributaries and least complex in streams of the Appalachian and Cumberland Mountains. Species richness, trophic relationships, and tolerance tendencies displayed considerable variation when similar size stream of different basins. Although the IBI method appears to be an excellent tool for evaluating lotic integrity, care must be taken when setting scoring criteria for each component.

200

FALBO, MARY BETH and THOMAS E. WEAKS. Marshall Univeraity--The physical and chemical effects of water hyacinth on toxic acid mine water.

The ability of the water hyacinth, Eichhornia crassipes (Mart.) Solms, to ameliorate acid mine pollution was tested for a period of 60 days. Under greenhouse conditions, water hyacinths were introduced and grown in acid mine water (initial pH - 2.95). Various physical and chemical parameters were assessed to determine water hyacinth efficiency in correcting acid mine pollution. Although plant growth and reproduction were dramatically curtailed by the presence of acid mine conditions, no plant loss occurred. Acid mine water containing plants resulted in consistantly higher pH values in comparison to controls containing no plants. Acid mine water treated with water hyacinths reflected a general overall reduction in acidity, total iron, sulfates and residue.

201

HOYLMAN, A. M., A. ATAKKAAN, M. D. ADKINS, M. C. WALDRON, and A. R. WHITE. Marshall University--Mutagenicity of organic extracts of Kanawha River sediments.

The Kanawha River has a long and diverse history of mining, manufacturing, industrial and municipal use. As a preliminary step in a project designed to identify historical trends in the deposition of biologically hazardous materials in sediments of the Kanawha River, we determined levels of mutagenic activity in organic extracts of surface sediments collected at sites upstream and downstream from the chemical manufacturing complex at Charleston, West Va. Sediment samples were prepared for extraction by milling a portion of wet sediment with anhydrous sodium sulfate. This procedure reduces the time required for complete extraction and so minimizes production of mutagenic artifacts. After milling, each sediment sample was extracted sequentially with four solvents: Freon 113, methylene chloride, acetone, and methanol. Bacterial mutagenicity tests were performed on each solvent fraction using Salmonella tester strains TA98 and TA100, with and without Aroclor-induced rat liver microsomal (S-9) enzymes. Methylene chloride extracts from both sediment samples induced dose-dependent responses 2-3 times higher than background in strain TA98 with S-9 activation, indicating the probable presence of frame shift promutagens in these sediments. Similar results were obtained for acetone and methanol extracts from the upstream sediment sample. Only one fraction, the acetone extract from the upstream sediment, showed any mutagenicity in strain TA100. Work is currently underway to isolate and identify compounds responsible for observed mutagenic effects. (Supported in part by grant number 86-106 from the Virginia Environmental Endowment.)

202

STOKES, GLENN D. AND WILLIAM S. BIRKHEAD. COLUMBUS COLLEGE--pH discrimination of two Cyprinid fish.

Notropus euryzonus and N. venustus are found in confluent creeks (Pineknot Cr. and Upatoi Cr. respectively) but are not observed crossing between creeks. Although no mechanical barrier is present the creeks differ in pH by a minimum of 2 units year-round. It has been demonstrated that the pH range of Pineknot Cr. (3.5 - 5.3) is acutely toxic to N. venustus (93.7% mortality in 96 h) while that of Upatoi Cr. (6.0 - 7.1) is less toxic to N. euryzonus (45.8% mortality in 96 h). It was proposed that the two fish species can discriminate differences in water on the basis of pH. A plexiglas test chamber was constructed that allowed the fish to freely choose between water pumped (14.5 l/min) from each creek. Only fish that crossed two or more times in the five minute trial period were considered. N. venustus (n = 21) spent 4.55 ± 0.82 min in the side containing their native water crossing 6.35 ± 5.23 times (range: 2 - 20). N. euryzonus (n = 18) spent 2.06 ± 1.67 min in their native water crossing 5.92 ± 5.32 times (range: 2 - 26). There was no significant difference in the results when the water source orientation was reversed in the test chamber. Sensory discrimination is sufficient to explain the debarment of N. venustus from Pineknot Cr. but does not explain the exclusion of N. euryzonus from Upatoi Cr.

203

SHAFFER, GARY P. Louisiana State University--K-systems analysis: a powerful new technique for analyzing ecological data.

K-systems analysis represents a paradigm shift in multivariate data analysis. Explicit examples are discussed and comparisons made between K-systems analysis and 1) factorial ANOVA and 2) multiple regression analyses. The later techniques are designed to isolate overall or average effects. Consequently, these techniques are biased towards variables which contain broad or global effects and biased against variables whose effects are important, yet encompass a relatively narrow range of the data set. Unlike classical statistical procedures, K-systems analysis analyzes the data in pieces (i.e., states and substates), extracting only the pieces which contain the information. Consequently, this type of analysis can pick out critical behaviors between variables which would normally go unnoticed.

204

DENDINGER, JAMES E. James Madison University--Digestive proteases in the midgut gland of the Atlantic blue crab, Callinectes sapidus.

Digestive proteases from the blue crab midgut gland were investigated. Tentative identities of proteolytic enzymes were determined with synthetic substrates and inhibitors. Trypsin, chymotrypsin, carboxypeptidase A and B, and leucine aminopeptidase activities were found and quantified. Activity against succinyl-(Ala)-nitroanalide was also found. This as yet unidentified enzyme has a molecular weight of about 26,000 daltons and has elastolytic activity.

205

HENDERSON, INGRID L., CLETUS M. SELLERS, JR., NORMAN E. GARRISON, and DAVID R. ORVOS. James Madison University--Effects of chlorination upon ability of the cytosolic components to support in vitro translation by rainbow trout (Salmo gairdneri) hepatic ribosomes.

The exposure of rainbow trout (Salmo gairdneri) to intermittent chlorination produces an increase in total plasma protein, but reduces concentrations of ceruloplasmin and fibrinogen. Since these proteins are produced in the liver, alteration in their concentrations indicates possible hepatic dysfunction. Previous studies in this laboratory have demonstrated that amino acid incorporation ability does not appear to be affected; however, it was also shown that ribosomal translational efficiency differed between control and experimental animals 4 h after toxicant initiation. The present study examined the effect of chlorination upon cytosolic proteins, such as initiation and elongation factors, which are essential for completion of protein synthesis. An analysis of 72 fish revealed no significant difference in the amount of ^{14}C-phenylalanine incorporated by control and experimental groups. Therefore, it appears that chlorination does affect translational efficiency, but not amino acid incorporation or cytosolic factor utilization.

206

FARRAR, WILLIAM W. Eastern Kentucky University--Purification and properties of pig liver and muscle enolases.

Enolases were purified to homogeneity from pig liver and pig muscle and their physical and kinetic properties compared. Sedimentation equilibrium ultracentrifugation indicates that the molecular weight of pig liver enolase is 92,000 and that of muscle enolase is 85,000. Both enolases are dimers with subunit molecular weights (by SDS gel electrophoresis) of 46,000 (liver enolase) and 44,000 (muscle enolase). These structural data show that pig liver and muscle enolases are within the molecular weight and subunit composition ranges of other enolases studied. Amino acid composition data support the sedimentation equilibrium results. The two enolases differ from one another in their content of lysine, serine, proline, and cysteine. They also differ in their isoelectric points ($pI_o = 6.4$ for the liver form, and 8.8 for the muscle form), their catalytic pH optima (7.4 for liver enolase, and 6.8 for muscle enolase), and their degree of inhibition by LiCl. Despite these differences, the kinetic constants (Km for Mg^{2+}, 2-phosphoglycerate, and phospho(enol)pyruvate) seem not to be significantly different.

207

KIFFMEYER, WILLIAM R. and WILLIAM FARRAR Eastern Kentucky University--Purification and properties of pig heart pyruvate kinase.

Pyruvate kinase (EC 2.7.1.40) is an important regulatory glycolytic enzyme and has been isolated from several tissues, including pig liver. In an effort to compare and understand the regulation of glycolysis in a gluconeogenic and nongluconeogenic tissue, we have engaged in a study of pig heart pyruvate kinase. We have purified pyruvate kinase from pig heart to greater than 97 percent purity using essentially a two-step procedure involving phosphocellulose ion-exchange column chromotography followed by gel-filtration on Sephadex G200. Sucrose density gradient ultracentrifugation yielded an $S_{20,w}$ of 10, and a corresponding molecular weight of about 240,000. The pig heart enzyme cosediments with rabbit muscle pyruvate kinase. In addition, SDS polyacrylamide gel electrophoresis of purified pig heart enzyme gave a subunit molecular weight of 58,000 - 60,000. These structural data suggest that pig heart pyruvate kinase is similar to the pyruvate kinases examined from other tissues and species, especially rabbit muscle. The isoelectric point for pig heart pyruvate kinase lies between 8.5 and 9.5. The isoelectric point for the bovine heart enzyme is between 7.5 and 8.0, and that for pig liver is 6.1 suggesting that pyruvate kinase exists in multiple molecular forms in the pig. Along with the above data, we are presently obtaining kinetic parameters and the amino acid composition in order to compare these with pig liver pyruvate kinase and to understand the regulatory role of these two enzymes in heart and liver.

208

FARRAR, WILLIAM W. and YOUNG JO K. FARRAR Eastern Kentucky University--Steady-state kinetic mechanisms of house sparrow heart and flight muscle lactate dehydrogenases.

Lactate dehydrogenase (LDH) isoenzymes catalyze the reversible interconversion of pyruvic and lactic acids using NAD^+/NADH as electron acceptor/donor. We have purified to homogeneity the LDH isoenzymes from house sparrow heart and flight muscle and compared their steady-state kinetic mechanisms by initial velocity and product inhibition studies using a Bausch and Lomb Spectronic 2000 equipped with a kinetics program. Due to substrate inhibition which necessitated the use of lower reactant concentrations, heart LDH proved to be the more difficult enzyme to investigate by steady-state means. With NADH as the variable substrate and pyruvate as the fixed variable substrate, the initial velocity patterns for both heart and muscle LDH is intersecting indicating that the mechanism is not ping-pong. Of the product inhibition studies the only competitive inhibition pattern obtained for both enzymes was with NADH as the variable substrate (at a fixed, nonsaturating level of pyruvate) and NAD$^+$ as product inhibitor. The other patterns (NADH vs. lactate, pyruvate vs. lactate, and pyruvate vs. NAD$^+$) exhibited noncompetitive inhibition. These data suggest that both enzymes have the same mechanism, one that is sequential-ordered in which NADH adds first followed by pyruvate and then the ordered release of lactate and NAD$^+$.

209

POULOS, JOHN E. and GERHARD KALMUS
East Carolina University-- The Effects of Indomethacin and Dexamethasone on Fibroblast Chemotaxis.

cute inflammation involves the release of protaglandins and leukotrienes by damaged tissues nd inflammatory cells. Following this response repairative phase is initiated due to ibroblast recognition of chemoattractants eleased by the inflammatory site. The purpose f this study was to determmne the effect of ndomethacin and dexamethasone on fibroblast hemotaxis. Indomethacin is a non-steroidal nti-inflammatory agent that inhibits phosphoipase A_2 and cycloxygenase. This inhibition educes the availability of arachidonic acid and rostaglandins. It was determined that indomethcin at a concentration from $1x10^{-4}$ to $1x10^{-7}$M. did ot inhibit, but enhanced fibroblast chemotaxis. his may be due to the accumulation of arachionic acid due to inhibition of cycloxygenase. his arachidonic acid is then free to be acted pon by 5-lipoxygenase thereby producing eukotriene B_4, a potent chemoattractant for ibroblasts. Dexamethasone is a glucocorticoid hat inhibits phospholipase A_2 activity and eutrophil chemotaxis. This inhibition is due to he induction of a protein named lipocortin. Our tudy also showed that dexamethasone has little o no effect on fibroblast chemotaxis in a oncentration range from $1x10^{-4}$ to $1x10^{-7}$M. herefore, glucocorticoids may act in decreasing the ntial influx of neutrophils thereby allowing ibroblast migration to the wound site resulting in ell proliferation, collagen synthesis and repair f the connective tissue matrix.

210

SILVER, STAN L. and VALGENE L. DUNHAM.
Western Kentucky University--The in vitro translation of glutamine synthetase.

Two isoforms of glutamine synthetase have been isolated and partially purified from 4-day-old etiolated soybean hypocotyls. Using ammonium sulfate precipitation and DEAE ion-exchange chromatography. The two forms were eluted from a DEAE-cellulose column by step or linear gradients at 0.08 m KCl and 0.2 m KCl, respectively. Total RNA was prepared by a phenol-chloroform extraction. Poly A mRNA was isolated from the total RNA by Hybond mAP paper. Poly A mRNA was then employed in several in vitro translation experiments using a wheat germ translation system. The translation product was then subjected to DEAE-cellulose chromatography on a 1 ml DEAE cellulose column. A single peak of glutamine synthetase activity was partially purified from the translation products. These results indicate the presence of an abundant mRNA coding for at least one of the isoforms of glutamine synthetase.

211

MURPHY, KIMBERLY R. and GEORGE G. MURPHY.
Middle Tennessee State University--Toxicity of ovarian eggs of Bufo americanus to Mus musculus.

Assays were conducted to determine acute toxicity and median lethal dose (LD_{50}) of ovarian eggs of the American toad, Bufo americanus, to adult male house mice, Mus musculus. Toxicity of jelly-coated and non-jelly-coated ovarian eggs was tested by intraperitoneal injections of 1 ml of an homogenate, consisting of eggs and 0.9% isotonic saline, into a laboratory strain of white mice. Results showed that Bufo americanus eggs were toxic to mice. The onset of symptoms typically occurred within 2-5 minutes and death within 5-16 minutes following injection. Ultracentrifugation of the homogenized egg cells into subcellular fractions showed that the toxic component(s) remained in solution after 16.25 hrs at 87,000 x g. Dry heating of the lyophilized cell soluble fraction to 120° C for one hour completely denatured the toxin, while ultrasonic disruption had no apparent effect.

212

MEFFE, GARY K. and ANDREW L. SHELDON.
Savannah River Ecology Laboratory and The University of Montana--Habitat Selection by Dwarf Waterdogs (Necturus punctatus) in South Carolina Streams, with Life History Notes.

In fall 1985 we collected dwarf waterdogs (Necturus punctatus) in first to third order blackwater streams tributary to the Savannah River in central South Carolina. Quantitative environmental data from each collection site (n = 49) permitted univariate and principal components analyses of habitat selection by waterdogs. These animals prefer deeper sections of streams with slow currents, undercut banks, and an accumulation of mud, silt, and leaves. Examination of preserved specimens indicates maturity at 70-80 mm snout-vent length, an increase in number of ova with body size, longer tails in females than males, and asymmetry in ova production by the two ovaries. Food items include earthworms, chironomid larvae, crayfish, mayfly nymphs, and salamanders, but over one-half of the 50 waterdogs collected had empty stomachs.

213

ARNDT, RUDOLF G. and A. BRETT BRAGIN. Stockton State College, Pomona, NJ--Status and ecology of Ambystoma t. tigrinum in Delaware. In summer 1986 we attempted to locate on USGS maps every potential Delaware breeding pond of the eastern tiger salamander and to sample these ponds by seine for its larvae. Some 178 potentially suitable ponds (lacking a stream inflow and outflow) were map-located and 165 of these found and examined. Larvae were found in eight natural vernal and man-made permanent ponds, all at least partly bordered by mature deciduous or mixed forest. Larvae were absent from ponds with fishes. At least three other ponds, dry when sampled in 1986, are known breeding ponds. Many other ponds dry in 1986 probably are successfully used for reproduction in a more wet year. Post-metamorphic larvae and an adult collected in earlier years could not be identified with a breeding pond. The data indicate that annual reproductive success can vary tremendously, and that the species is more widely distributed and abundant than previously known.

214

IRELAND, PATRICK H. Radford University--Effects of chronic sub-lethal exposure of salamanders to acid rain.

Salamanders present a useful model for investigation of the effects of chronic exposure to sub-lethal levels of acid deposition. Some species are exposed to high levels of acid deposited in fog and their water permeable skin places them at risk to cellular damage from atmospheric oxides of sulfur and nitrogen. The cellular response to free radicals of sulfur and nitrogen from both physiological redox reactions and exogenous environmental sources is cumulative peroxidation of sub-cellular membrane lipids yielding residual bodies of lipofuscin. These residual bodies are sequestered within cells and remain throughout the life of the cells. The lipofuscin level within cells is a function of the age of the cells and the amount of damage inflicted by free radicals. Salamanders living at high altitudes have greater lipofuscin levels in some tissues than salamanders living at lower altitudes suggesting that at higher altitudes the exposure to free radicals is greater than at lower altitudes. Preliminary data indicate lipofuscin is induced by exposure to free radicals of sulfur and nitrogen but not by hydronium. This suggests that the level of sulfur and nitrogen oxides in the environment may be more critical than the hydronium concentration. Salamanders are sensitive to acid deposition and may be a useful model for investigating the effects of acid deposition on terrestrial animals.

215

HINTON, THOMAS G.,[1] F. WARD WHICKER,[2] and JOHN E. PINDER, III.[1] Savannah River Ecology Laboratory[1] and Colorado State University[2]--The kinetics of Ca, Sr and Ra in the pond slider (Trachemys scripta) as influenced by dietary calcium.
Experiments were conducted on the comparative kinetics of Ca, Sr and Ra in the pond slider. Various sized animals of both sexes were maintained in enclosures within a 18 X 20 m pond, fed on diets containing either 0.2% or 2.0% Ca, and gavaged with ^{226}Ra, ^{85}Sr, ^{45}Ca and ^{47}Ca. Serial whole body determinations of radionuclide contents were performed on live animals with a Germanium semiconductor detector. The curve of activity versus time was modelled by a two-component elimination curve. Initial results indicate significant differences in the assimilation fraction with Ca > Sr > Ra. The assimilation fractions and biological half-times for all three isotopes were greater than similar values for mammals.

216

DODD, C, KENNETH, JR., KEVIN M. ENGE, and JAMES N. STUART. U.S. Fish and Wildlife Service--Reptiles on highways in north-central Alabama: species, mortality, and environmental influences.
Species and numbers of reptiles encountered alive and dead on highways in north-central Alabama were tabulated for 135 days between April and September 1985. A total of 303 specimens of 19 species was recorded for >19,000 km roads surveyed. There was no statistically significant relationship between the number of dead (DOR) reptiles and traffic volume, or between the total number of reptiles and maximum or minimum air temperature. However, numbers varied seasonally (defined in two-week intervals) and were weakly correlated with daily rainfall. The only strong correlation was with effort: the more kilometers driven, the greater the number of reptiles encountered.

Road cruising probably is not a reliable sampling technique for determining species richness or abundance of most reptiles. Carefully planned surveys will be necessary to assess the impacts of highway traffic on adjacent reptile populations, and even such studies may be of limited value because of logistic and interpretive difficulties.

217

DODD, C. KENNETH, JR. U.S. Fish and Wildlife Service--The effects of disease on the flattened musk turtle, Sternotherus depressus.

Sipsey Fork, a stream in north-central Alabama, contains the largest known population of the flattened musk turtle, Sternotherus depressus, a candidate species for threatened status under U.S. federal law. The stream was surveyed during July 1986 to determine the effects of a severe disease initially observed during surveys in 1985. The population declined by 50% from the end of June through late July 1985, but the 1986 survey found no additional decline. The population structure was similar between years, although the sex ratio changed from 1.7:1 to 1.5:1, a significant difference. The overall trapping success ratio was less than previous studies, although the relative capture success by station was similar to that observed in 1985. No severely diseased turtles were found, although ~12.5% had mild symptoms and 17% appeared to have recovered. There was no sex bias either in disease symptoms or recovery when compared with the overall sex ratio. The disease was characterized by a mixed gram-negative septicemia most likely resulting from an improperly functioning immune system. Assessing the importance of disease to the decline observed in the population is hampered by the activities of commercial collectors who are known to have removed turtles from Sipsey Fork in July 1985.

218

FORESTER, DON C., DAVID V. LYKENS, and W.K.HARRISON. Towson State University--Sexual selection in the spring peeper: is female choice dependent on male calling persistence?

In recent years attention has focused on the role of the mating call in sexual selection. Various spatial and temporal call parameters have been proposed as indicative of male fitness. In this paper we present the results of observations and experiments designed two resolve two questions: (1) Do males devote a differential amount of their time to vocal advertisement? (2) Are females more likely to respond to persistent callers in an artificial chorus? The answer to both questions is yes. On "peak" evenings, most males called continuously throughout the one hour observation period, while on "non-peak" evenings there was a great deal of variation. Given a choice of speaker-traps broadcasting 20, 40, 60, and 80% of the time respectively, females exhibited a preference for the more persistent traps. Females responded randomly when given a choice of the same traps broadcasting 80, 85, 90, and 95% of the time. Calling is energetically expensive and exposes males to increased risks of predation. Never the less, individuals which employ a strategy of persistent calling will maximize their fitness. We conclude the benefits outweigh the costs.

219

FUGLER, CHARLES M. and GROVER C. MILLER. University of North Carolina at Wilmington, and North Carolina State University--A dry-season herpetological community in Amazonian Bolivia.

Preliminary field studies at Tumi Chucua in the tropical rainforests of Amazonian Bolivia indicate that the active dry-season herpetofaunal community includes at least 55 species. Nineteen anurans, thirty ophidians, eleven saurians, three chelonians and two crocodilians have been identified. The major phytological formations within the terra firma and varzea are delineated. The species diversity and species density within the phytological formations are estimated. The spatial and temporal distribution of the species within the phytological formations are defined. The relative abundance of exclusively aquatic species is estimated.

220

LOVICH, JEFF. Savannah River Ecology Laboratory--Geographic variation in the seasonal activity of spotted turtles, Clemmys guttata.

Throughout their extensive north-south distribution, spotted turtle (Clemmys guttata) populations are active primarily in the spring. Yet, there are significant differences in the timing and duration of this activity, even at similar latitudes. In general, northern populations initiate activity later in the year in comparison with southern populations. Differences appear to be correlated with climatic factors, and are consistent with thermal preferences reported for the species. The ability to shift activity patterns in response to various climatic regimes may partially explain the present distribution of the species.

221

WALLIN, JULIE and J. WHITFIELD GIBBONS. Savannah River Ecology Laboratory--Growth of juvenile slider turtles (Trachemys scripta) as a consequence of sex, year and habitat.

Growth rates of juvenile slider turtles in natural populations were examined utilizing annuli measurements as indicators of size in earlier years to generate growth curves for individual turtles. Regression equations from the plots of total length vs. scute size for each population enabled us to estimate size in earlier years from annuli measurements. Growth rates for the first seven years were then determined. Comparisons of growth rates between the sexes, between two distinct populations and among cohorts within each population were made. Although there is sexual dimorphism in adult body size and age at maturity, growth rates of juvenile turtles were not found to vary between the sexes. Growth rates were significantly different between the two populations studied, probably due to habitat quality. Differences in growth rates among cohorts attributable to differences between years were not detectable. The use of a regression equation to determine size in previous years was demonstrated to be an effective and reliable method of studying growth characteristics of turtles. The use of this method to determine growth curves for individual turtles expands our information on growth rates from field data and allows investigators to examine growth patterns in natural populations of aquatic turtles.

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ECKERT, KAREN L. University of Georgia --Tag loss and the estimation of sea turtle abundance.

Very little is known of the demography and status of endangered sea turtle populations. This study suggests that if tag loss can be accounted for, long-term tagging efforts directed toward nesting turtles can be important in providing information relevant to population size, survivorship, remigration and recruitment. The Jolly-Seber stochastic method for estimating animal abundance was used to estimate the size of Little Cumberland Island, Georgia, population of loggerhead sea turtles (*Caretta caretta*) from the number of turtles nesting annually (1964-1981). The method estimated an annual population size of 175-417 turtles (x=293.74, SD=88.35), with 26% of them nesting during any given year. Estimated annual survival rates ranged from 0.48-1.29 (x=0.94, SD=0.26). An average of 29% of the turtles captured per annum had lost all previously placed tags. When these individuals were incorrectly identified as unmarked, population size was over-estimated and survival under-estimated. In addition, the standard errors around both parameter estimates were consistently larger than when tag loss was accounted for. Six years of saturation tagging were required before population estimates were available, annual recruitment was relatively constant and tag loss was non-random. The implications for sea turtle conservation and management are discussed.

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ECKERT, SCOTT A. University of Georgia--Diving patterns with a new deep diving record for the Leatherback sea turtle, *Dermochelys coriacea*, during internesting intervals.

The Leatherback sea turtle, *Dermochelys coriacea*, has recently been shown to be an exceptional breath-hold diver. Additional work on the diving behavior of this reptile was carried out on St. Croix, US Virgin Islands, in 1985. Time-depth recorders (TDR) were fit to six leatherbacks while nesting. Continuous diving patterns were recorded during one internesting interval for each turtle. The data was analysed for both diel and hourly periodicity. Constant diving was punctuated by short surface intervals and a new deep diving record was set for sea turtles as one leatherback dove beyond the TDR range to a calculated maximum depth in excess of 1000 m. Diving activity showed strong diel variation with mean diurnal (0500-1900 h) dives longer, deeper and less frequent than mean nocturnal dives. Surface times were longest between 1000-1400 h. These longer surfacing periods may represent thermoregulatory behavior. Surface time was independent of dive depth and dive duration implying that the leatherback does not typically use anaerobic metabolism for diving. Deeper dives were longer duration, suggesting that leatherbacks swim at steady speeds rather than changing swim speed as a function of dive duration or depth. Preliminary swim velocity results confirm this. There was no relationship between dive activity (depth, duration, frequency) and turtle size (mass, length). It is suggested that the primary purpose of the diving is to forage for deep water medusae.

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NELSON, DIANE R. and GEORGE MUSIL. East Tennessee State University--Electron microscopic observations of the tardigrade *Macrobiotus tonollii*.

Macrobiotus tonollii Ramazzotti 1956 is a cosmopolitan tardigrade frequently found in mosses growing on the bark of live trees. Specimens were collected from this habitat on the grounds of the Veterans Administration, Mountain Home, Tennessee, and were prepared for observation with transmission and scanning electron microscopy. A modified technique was developed for transmission electron microscopy. Species identifications of extended anoxic (inactive) animals were verified with a light microscope. Reviving animals were cut, and the specimens were fixed in OsO_4 and embedded in Spurr's epoxy resin. Thick sections (1 µm) were stained with toluidine blue for light microscopy. Thin sections were stained with uranyl acetate and lead citrate and examined with a Phillips 201 transmission electron microscope. Observations were made primarily on the fine structure of the digestive system, nervous sytem, muscular system, and the cuticle. Standard SEM procedures for tardigrades were followed, and the external anatomy of adult specimens and eggs were examined with an ETEC Autoscan scanning electron microscope.

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NELSON, DIANE R.,[1] RUDOLPH PRINS,[2] and ROBERT O. SCHUSTER.[3] East Tennessee State University,[1] Western Kentucky University,[2] and University of California-Davis[3]--Preliminary report on Tardigrada from Southern Chile.

Few studies of the tardigrade fauna of South America have been conducted, and only about 100 species from the continent have been reported in the literature. To survey the tardigrade species of Southern Chile, samples of mosses and lichens were collected by Rudolph Prins while on a sabbatical at the University Austral de Chile, January-June 1984 and June 1985. More than 100 collections were made in a large geographical area from Temuco to the Straights of Magellan (over 1500 miles). The samples were processed, and tardigrades and eggs were extracted and mounted on slides for identification. Preliminary examination of specimens revealed 14 species (excluding those in the genus Macrobiotus). The following genera were represented in the collection: Echiniscus (one species), Pseudechiniscus (one species), Mopsechiniscus (one species), Hypsibius (three species), Isohypsibius (three species), Diphascon (four species), and Milnesium (one species). New distributions will be recorded and the new species will be described.

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BROWN, K.M., AND T. D. RICHARDSON. Department of Zoology and Physiology, Louisiana State University, Baton Rouge, Louisiana, 70803--The effect of predator size and density on the foraging ecology of Thais haemastoma.

We noted that populations of the Southern oyster drill, Thais haemastoma, differed in mean shell length and density, but always possessed a clumped dispersion pattern. We completed a number of experiments in the laboratory to determine the role of predator size and density on feeding rates, handling times, and prey choice on three prey: Oysters (Crassostrea virginica), clams (Rangia cuneata), and mussels (Ischadium recurvum). Small drills could eat only small mussels but switched to feeding on larger prey with longer handling times such as oysters as the drills grew, or were allowed to feed in groups. Handling times were not dependent on density but did decline for all prey types as the predators increased in size. We divided dry mass of prey consumed by handling time to give an index of prey profitability. Mussels were the most profitable, followed by clams and oysters. In time-lapse video tape experiments, oyster drills chose the more profitable mussels over the other two prey types, leading us to believe that the Southern oyster drill chooses its prey in an optimal fashion. Ischadium and Rangia are found only in estuarine areas along the Louisiana coast where oyster drills are not common, leading us to suggest that the Southern oyster drill may in part control their distribution.

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RICHARDSON, TERRY D. AND JOSEPH F. SCHEIRING. Louisiana State University and University of Alabama--Life histories of Elimia clara and E. cahawbensis (Gastropoda: Pleuroceridae).

The population ecology of pleurocerid snails is relatively unknown. The life histories of two coexisting pleurocerids, Elimia clara and E. cahawbensis, from Little Schultz Creek, Bibb County, Alabama, were investigated. The two species differed in density, mean shell size, microhabitat preference, and the occurance of symbiotic organisms. Age at first reproduction, determined from observing relative size of gonads, was two to three years of age for E. clara and four to five years of age for E. cahawbensis. Both species had reproductively active individuals all year and sex ratios of 1f:1.4m. Size specific growth was determined from laboratory and stream growth chambers. Annual growth for E. clara was 0.14 mg AFDM/mg AFDM of body tissue and 0.32 mg/mg from stream and laboratory estimates, respectively. The corresponding values for E. cahawbensis were 0.23 mg/mg and 0.29 mg/mg. Maximum length of life estimated from these size specific growth rates was up to 19 years for E. clara and 18 years for E. cahawbensis. Thus, these freshwater snails may be among the longest lived freshwater invertebrates.

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SMITH, CRAIG M. and COURTNEY T. HACKNEY. University of North Carolina at Wilmington --Effects of Hydrocarbon Covered Substrate on Intertidal Recruitment of Crassotrea virginica

The recruitment of the American oyster, Crassotrea virginica, was measured at three intertidal elevations (high, medium and low) in a southeastern North Carolina estuary during summer 1986. Clam shells were soaked in Bunker C crude oil or a 40:1 gas/two cycle engine oil mixture and exposed for 13-day periods. In early summer, spat densities exceeded 24/cm^2 and barnacles 27/cm^2. Spat densities were significantly reduced on Bunker C treated shells at the high intertidal site as compared to controls. Densities of barnacles, primarily Balanus improvisus, were significantly higher on Bunker C treated shells. Settlement of encrusting bryozoans, primarily Schizoporella unicornis, was reduced on Bunker C shells at low intertidal elevations.

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JOY, JAMES E. and JEFF W. HIVELY. Marshall University--*Unionicola* sp. (Acarina: Hydracarina) infection in *Anodonta imbecillis* (Say), at the McClintic Wildlife Station, Mason Co., West Virginia.

A total of 174 freshwater mussels, *Anodonta imbecillis* (Say), were collected from two McClintic Wildlife Station ponds and examined for the presence of water mites, *Unionicola* sp. (probably *U. formosa*). From an ancillary study Pond 14 had been characterized as a moderate density pond (~ 13 clams/square meter), while Pond 27 exhibited a high density (~ 30 clams/square meter). Collections were made monthly from May through November 1986. Prevalence of mite infections was 100% for clams in both ponds, however, intensity of infection (mean mites/host) was 9.5 and 23.6 for the moderate and high density ponds, respectively. Monthly variation in intensity of infection was also observed. The lowest intensity occurred in May (5.4 for P-14; 19.7 for P-27) and the highest intensity was recorded for August (12.9 for P-14; 31.3 for P-27).

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ECKERT, KAREN L. and SCOTT ALAN ECKERT. University of Georgia--Growth rate and reproductive condition of the barnacle, Conchoderma virgatum, on gravid leatherback sea turtles in Caribbean waters.

Leatherback sea turtles (Dermochelys coriacea) nesting at regular intervals on Sandy Point, St. Croix, provided an opportunity to obtain multiple measurements of Conchoderma virgatum, an epibiotic cirriped. Size at sexual maturity, growth rate and asymptotic size were documented. Individuals as small as 8.8mm (capitular length) were found to be gravid. A growth curve was developed after fitting paired measurements (capture and recapture) from 43 individuals to the von Bertalanffy growth interval equation (Fabens, 1965) and obtaining estimates of asymptotic length and intrinsic growth rate using SAS non-linear least-squares regression procedures. The predicted asymptotic size of 14.6mm (capitular length) is considerably less than that reported elsewhere for the species. Physiological stress associated with the terrestrial nesting phase of the host turtle may have prevented the species from attaining full growth potential. Considerable plasticity in both maximum size and intrinsic growth rate may exist between populations of Conchoderma virgatum exposed to different physio-ecological regimes. Temporal and spatial colonization patterns of cirripeds on gravid leatherbacks in Caribbean waters suggest that the turtles migrate from temperate waters to tropical nesting grounds. Growth rates of newly colonized Conchoderma virgatum suggest that most leatherbacks commence nesting within two weeks of arrival at the nesting grounds.

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Crooks, Fred B. Southern Illinois University, Carbondale.-Determining the presettlement forest stand composition and basal area using the original land survey records for the Shawnee Hills Physiographic Region of Illinois.

The original land survey for Southern Illinois, which includes the Shawnee Hills Physiographic Region, was completed in 1807. The records from this survey, along with field verification, are being used to determine the presettlement forest stand composition and basal area for four site-types: Ridgetops, North slopes, South slopes and Alluvial sites. Preliminary analysis indicates that the presettlement forest composition for each site-type is similar to that predicted by models which are based upon data from undisturbed old-growth stands located in the Shawnee Hills.

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EFIRD, ROBERT B. and K.M. PETERSON. Clemson University--Corm Dynamics and Clonal Propagation in Tipularia discolor.

Tipularia discolor (Pursh) Nuttall (Orchidaceae), a perennial herbaceous geophyte, persists as a series of connected corms through late spring and summer. One leaf is produced from each terminal corm in the autumn and remains photosynthetically active throughout the winter. This orchid propagates clonally through multiple corm formation (corm branching) and fragmentation of interconnected corm systems. Corm morphology is remarkably consistent with three distinct corm regions. New corms arise at two separate meristematic sites on corms. One daughter corm persists and one daughter corm aborts 93 % of the time; branching occurs in approximately 7 % of all corms (n=700). Leaf formation and flower buds occur at specific sites on all corms. Inflorescences develop from flower buds in approximately 11 % of corms. Branching corms are more likely to flower than corms which do not branch. Size of the terminal corm can be predicted from size of the attached leaf ($r^2 = 0.73$, n = 105), and corm size appears to influence both flowering and branching.

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BUSING, RICHARD T. University of Tennessee--*Spatial patterns of spruce-fir forest tree species*. Spatial patterns of *Picea rubens*, *Abies fraseri* and *Betula lutea* were determined in an old-growth stand at Mt. Collins, North Carolina and Tennessee. Three means of pattern estmation were used in the analysis: 1) Morista's index of dispersion for two size classes (subsaplings and trees), 2) nearest neighbor frequencies, and 3) correlations between distance to nearest neighbor and combined tree sizes. Morisita's index values indicated a tendency of clumping in all groups considered. *Betula* subsaplings showed the highest degree of clumping, while *Abies* trees approached a random dispersion pattern. All three species tended to be more dispersed in the larger size class. Interspecific nearest neighbor analyses of canopy trees revealed no interactions among *Picea*, *Abies* and *Betula*. Significant positive correlations between tree sizes and inter-tree distances were obtained for *Picea*-*Picea*, *Abies*-*Abies* and *Picea*-*Betula* indicating repulsion between large trees of these pairs. Community level processes are inferred from these intra- and interspecific spatial patterns.

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BUSING, R.T. and E.E.C. CLEBSCH University of Tennessee--*Two decades of change in an old-growth southern Appalachian spruce-fir stand*. Two 0.4-ha forest plots, originally surveyed in the 1960's, were resampled in 1986. The plots were located on the N slope of Mt. Collins, Tennessee, at elevations of 1750 and 1800 m. Prior to resampling we hypothesized several changes in stand composition, structure and growth caused by adelgid damage to Fraser fir: 1) fir basal area contributed by larger trees (>10 cm dbh) has declined, 2) fir basal area contributed by smaller trees (0-10 cm dbh) has increased, 3) red spruce basal area has increased,4) spruce density has increased, 5) 10-year radial increments have increased in spruce, 6) total sapling (0-10 cm dbh) density has increased, and 7) arboreal species diversity has increased. Stand-level changes included an increase in density and a decrease in basal area. All hypotheses except 3 and 5 were valid in at least one 0.4-ha plot.

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WALKER, J. and ROBERT K. PEET. Southeastern Louisiana University, University of North Carolina--*Structure and production in Atlantic and Gulf coast savannas.* The structure and production of species rich savannas in North Carolina and Mississippi were compared. Control and fertilized plots were established in 3 sites per state. Fertilizer additions included: (1)complete, (2)complete minus N (-N), (3)-P, (4)-N-P. Aboveground production was quantified with a seasonal harvest, and species richness in various quadrat sizes was determined. MS sites had a greater biomass than NC sites (186 vs 145g/.25m^2), but within state and site variations were high. Complete fertilization resulted in a 1.3-2.0 fold increase in biomass in all sites, with the maximum relative increase in the lowest production site. All NC sites showed a significant positive response to N additions. In MS response to N was positive but small; a stronger P effect was indicated. Species richness was uniformly high (e.g. 22-37 spp/.25m^2). Over all sites, richness was negatively correllated with biomass at a small scale, but positively correllated at the 2.5m^2 scale. Species lists and results of this study indicate strong regional similarities in savanna composition and structure. In the context of this structural convergence, the differences in community level responses to nutrient additions were unexpected.

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PINDER, J. E., III, F. B. GOLLEY, P. J. SMALLIDGE, N. J. LAMBERT, and R. F. LIDE. Savannah River Ecology Laboratory and the University of Georgia--*Seed production, seed dispersal, seedling establishment and seedling survivorship of loblolly pine trees in secondary succession.* Although the succession of Field 3-412 (a 36-year old, 150-ha old field) from grass to loblolly pine (*Pinus taeda*) cover is proceeding rapidly along the margins of the field, there has been relatively little reproduction of isolated, mature pines growing in the center of the field. Some of the isolated pines have produced numerous offspring, whereas others have produced few seedling or sapling trees. Research was initiated in 1984 to determine the factors responsible for the low rates of reproduction of isolated pines. Research to date has attempted to identify points in the life cycle of the pines where reproduction has failed. Results will be presented that: 1) compare seed production between years; 2) compare the dispersal distances of seeds to the establishment of seedlings around the mature trees; and 3) measure the survivorship of seedlings established in previous years.

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PINDER, J. E. III and K. W. McLEOD. Savannah River Ecology Laboratory--*Contaminant transport due to the retention of soil particulates on plant surfaces*.

Although the contamination of plant surfaces with soil particulates is a potentially important process affecting the mobility of insoluble contaminants in agroecosystems, few data are available to assess the significance of this mechanism for different crop species. Retention of soil particulates on plant surfaces may result in greater accumulation of radionuclides, heavy metals and hydrophobic organics in human foods than predicted from measures of root uptake. Retention of soil particulates on the surfaces of corn, *Zea mays*, and sunflowers, *Helianthus annuus*, grown under field conditions was documented using the Pu-238 content of the plants to indicate retention of Pu-238 contaminated soil. Despite differences in leaf morphology and growth form between corn and sunflowers, the amount of soil retained on plants was similar. Almost all the soil retention occurred on the lower 1 m of the vegetation. The height distributions of retained soil can explain previously observed differences among crops in the contamination of mechanically harvested grains with soil particulates.

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NIXON, ELRAY S., GENE A. SULLIVAN, STANLEY D. JONES, and GRETCHEN D. JONES. Stephen F. Austin State University.--*Species diversity of woody vegetation in the Trinity River Basin, Texas*.

Species diversity was determined, using the Shannon-Wiener Diversity Index, for 53 communities situated in the Trinity River Basin of eastern Texas. Communities were located at 14 study areas positioned systematically from Fort Worth southeastward to within six miles of Trinity Bay. Climatic and topographic moisture gradients exist ranging from mesic to hydric. Less mesic upper basin communities had lower diversity indices than the more mesic communities in the mid and lower basin, following a gradient of increasing annual precipitation. Topographically, communities inhabiting flats, sloughs or swamps produced lower indices than those in communities on higher ground. These data support the hypothesis that communities inhabiting stressful environments have less diversity.

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STEPHENSON, STEVEN L. Fairmont State College--*Distribution and ecology of Myxomycetes in the upland forests of southwestern Virginia*.

A comparative ecological study of the Myxomycetes (plasmodial slime molds) occurring in five different upland forest communities in the Mountain Lake area of southwestern Virginia was carried out during the period of 1982-86. Although the forest communities selected for study occupied different relative positions (from subxeric to mesic) with respect to an environmental moisture complex-gradient, a high degree of similarity existed among the communities for species composition of Myxomycetes. However, absolute abundance, species richness, and species diversity (as computed with Shannon's formula) were higher for the more mesic communities. In general, Myxomycetes appear to be rather opportunistic organisms, occupying those microhabitats suitable for their growth and development as these become available to them. Nevertheless, considerable resource partitioning among species would seem to exist, since characteristic patterns of microhabitat occupation and sporulation phenology were noted for most quantitatively important species.

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WHITE, DAVID A. Loyola University of New Orleans, Louisiana--*Sedimentation, plant colonization and succession on accreting mudflats within the Mississippi River delta - year 2*.

Louisiana's loss of coastal marshlands due to subsidence totals over 50 square miles annually. By levee construction and maintenance silt-ladden waters of the State's coastal rivers are no longer permitted to flood the marshland and thus accrete it. The Mississippi River is certainly foremost in rivers that could slow subsidence by again supplying silt and sand to the marshes. This study determined sedimentation rates, plant colonization rates and succession over two years on two accreting mudflats that have formed as a result of experimental levee breaching within the Mississippi River delta proper. First year sedimentation rates exceeded 10cm, while second year rates declined to 2.5cm on newly accreting mudflats and to 0.5cm on one and two year old mudflats. Thus, site size has increased from 4300m^2 to 41,100m^2. Colonization by plants has been rapid. The most important colonizers (from biomass determinations) have been *Sphenoclea zeylanica* and *Cyperus erythrorhizos*. Succession on two year old mudflats have developed extensive stands of *Scirpus deltarum*, *Leptochloa fasicularis*, *Echinochloa walterii*, *Cyperus difformis* and *Salix nigra*. Patches of *Sagittaria* spp., *Typha angustifolia* and several minor species appear by the end of the second year. Now, the mudflats are showing signs of senescing.

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Wu, Xinyuan and J. Frank McCormick. University of Tennessee--*Growth-patterns of red spruce in an old-growth spruce forest in Great Smoky Mountains National Park*.

The patterns of growth by which young red spruce trees reach the canopy may be described in terms of the distributions of the number of periods of suppression and release the young trees undergo and the lengths of suppression and release periods. Fifty canopy red spruce trees and 50 young red spruce trees (DBH greater than or equal to 6 cm and not in canopy) were sampled in two study sites along Noland Divide in the Great Smoky Mountains National Park. The results include the historical or "normal" growth pattern based on the analysis on increment cores from red spruce trees which reached canopy over 100 yr ago, the contemporary growth pattern based on the analysis on increment cores from red spruce trees which reached canopy recently and which have not reached canopy, and the comparison between the historical and contemporary growth patterns.

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CUNNINGHAM, JACKIE A. and J. FRANK MCCORMICK. University of Tennessee -- *Long term effects of ionizing radiation on a pine forest*.

Initial effects of ionizing radiations on plant communities are well documented, but very little is known about long term ecological effects. At the Savannah River Plant, near Aiken, South Carolina, a 40 acre forest was irradiated in 1966. During each season separate forest plots of approximately 10 acres each, received identical one month radiation treatments in order to determine the influence of season upon radiation sensitivity. Initial effects were described by Gary Miller in 1968. We are reporting results of a reinvestigation in 1985. Height and diameter were measured for all woody vegetation. One hundred trees were cored and annual increment of growth was measured for years 1966 to present. Data were analyzed using a two way ANOVA model. Main effects are season and level of radiation exposure. Both factors are significant after 20 years, as well as a significant interaction between these factors. From 1966 to 1971 annual increment of growth was strongly suppressed in trees which had received 700 R or more and was mildly suppressed in trees which received 170 to 650 R. Following this six year suppression of growth, annual increment of growth began to approximate that of non-irradiated control trees. Growth suppression is greatest in trees which were irradiated in the spring, and least in those irradiated in the winter. After 20 years, total volume of wood produced is directly related to season and level of radiation exposure.

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JOLLS, CLAUDIA L. East Carolina University--*Consequences of self-fertilization and the maintenance of gynodioecy in the bladder campion (Silene vulgaris)*.

Gynodioecy, the occurrence of hermaphroditic and female plants within the same population, has been hypothesized to promote outcrossing. This presumably confers an advantage on the offspring through the benefits of heterosis, the avoidance of inbreeding depression, or both. I tested this hypothesis by comparing offspring of gynodioecious *Silene vulgaris*. Seeds of self-fertilized hermaphrodites, cross-fertilized hermaphrodites, and cross-fertilized females were obtained by artificial pollinations of field plants. Four hundred randomly selected seed were weighed, sown without bias in a mist bed of a constant temperature greenhouse. For six weeks, I recorded germination daily, height weekly, and determined leaf number, area and biomass at the end of the experiment. Seeds of outcrossed females were significantly heavier than those of the selfed or outcrossed hermaphrodites (.9226 vs. .8414 vs. .8115 mg, respectively, F=7.45, df=2,397, p=.0007). These larger seeds of females germinated a day earlier on the average and with greater success than those of selfed hermaphrodites (12.6 vs. 11.6, F=3.72, df=2.328, p=.0251 and 86% vs. 77%, x^2=14.67, p=.001). Although there was no significant difference among offspring leaf number, the outcrossed females and hermaphrodites produced seedlings with greater leaf area than did selfed plants (9.3 and 9.0 vs. 6.8 cm^2, f=8.93, df=2.292, p=.0002). I discuss these results in light of the maintenance of females in populations of protandrous, entomophilous hermaphrodites and the possibility of adaptive cytoplasmic factors in gynodioecious taxa.

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HUNT, DAVID M. University of Georgia--*Delimitation of taxa within the Quercus laurifolia / Q. hemisphaerica complex*.

The laurel oaks of the southeastern U.S. Coastal Plain, *Q. laurifolia* Michx. and *Q. hemisphaerica* Bartr. ex Willd., have long been confused and have historically alternated between being recognized as separate species to being synonymized under *Q. laurifolia*. Also included in this complex are willow oak, *Q. phellos* L., and water oak, *Q. nigra* L. Apparent intermediates can often be observed in the field wherever any two of these taxa occur together and seem to stem from differential abundance of hybridization among the four taxa in the complex. An extensive sampling of the four oaks was performed throughout their entire geographic ranges to examine natural variation. Intensive studies of flavonoid chemistry and leaf shape quantification were completed and coupled with intuitive interpretations of field and herbarium observations. *Quercus laurifolia* and *Q. hemisphaerica* appear to differ significantly in chemistry and leaf shape and also show different ecological requirements, phenology and morphological characteristics of leaves, acorns and habit. The magnitude of differences between these two taxa are comparable to differences between well-defined oak species.

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MULARONI, TERESA C. and DR. CHARLES E. ANDERSON. North Carolina State University--An anatomical glimpse at the unusual root system of Liriope.

Liriope muscari and L. spicada, whose origins can be traced back to Japan and China, are ornamental grasses that display a rather complex fibrous root system made up of three different types of roots. smooth, contractile and "tuber" roots. Smooth roots are similar in morphological and cellular structure to most adventitious roots, while contractile and "tuber" roots are somewhat less normal in composition. Contractile roots are generated early in the plant's life and function primarily in pulling down and maintaining the seedling within the substrate. Contraction of the cortical cells causes subsequent crushing and misalignment of the outer cortical and epidermal cell layers and is, therefore, responsible for their unusual wrinkled appearance. "Tuber" roots, as both Bailey and Arbor have termed them, are undoubtedly the most unusual of these three root types. These structures can be described as localized areas of swelling and they appear to be a result of extensive cortical cell expansion. This peculiar type of cell growth along with reduced lignification of the endodermis distinguish the "tuber" roots from the more normal smooth roots. Many think these structures have some sort of propagative value.

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MACRANDER, A. MICHAEL and ROBERT R. HAYNES. University of Alabama--Computer Inventory of the Vascular Flora of Alabama.

The computerized flora of Alabama, currently under development at the University of Alabama Department of Biology, provides the necessary structure for a valuable research, educational, management, and developmental tool. Taking advantage of recent advances in micro-computer processing speeds and storage capacities, the system is available at relatively low cost yet affords the full range of data management and search capabilities. At its full implementation, the system will offer dial-up service to flora users, thus creating an accessible central database for Alabama collections. In addition to on-line search capabilities, on-line up-date will provide for system revision for consistent information quality.

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BALLARD, ROBERT E. AND COLLEEN D. CRISLIP. Clemson University--Leaf Flavonoids of Actinidia.

Foliar flavonoid data are presented for Actinidia chinensis Planchon, A. kolimikta Maximowicz and Ruprecht, A. polygama (Siebert and Zuccarini) Maximowicz, A. melanandra Franchet, and A. arguta (Siebert and Zuccarini) Planchon ex Miquel. Each taxon can be distinguished chemically by differences in the flavonoids accumulated in their leaves. Flavonol O-glycosides are the dominant compounds and occur in all taxa. Flavanones are found in A. chinensis and A. arguta and C-glycoflavones occur in A. polygama.

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YOUNG, ELIZABETH G. AND ROBERT E. BALLARD. Clemson University--Flavonoid variation in Prunus persica cultivars

Flavonoid constituents of the leaves and fruit skins of nine peach and one nectarine cultivars were isolated and purified using paper chromatography and analyzed using a combination of UV spectral analysis and acid hydrolysis. The leaves of these cultivars contain kaempferol and quercetin 3-O-mono-, 7-O-mono-, and 3,7-O-diglycosides some of which occur as acylated derivatives. The fruit skins accumulate cyanidin, kaempherol and quercetin 3-O-monoglycoside and acylated quercetin 3-O-monoglycoside. The fruit skin flavonoid chemistry was uniform in all cultivars sampled, however, both qualitative and quantitative differences were found in the leaf flavonoid chemistry.

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McKINNEY, LANDON E., Vanderbilt University---Viola subsinuata Greene: A resurrected name for an old species.

During the process of revising the acaulescent blue violets of North America, it has become apparent that the violet recognized as Viola palmata L.(fide Ezra Brainerd, 1924) does not match well with the Linnaean type and description of that species. Linnaeus undoubtedly had in mind a heterophyllous violet with the earliest leaf blades undivided, the later ones parted or divided three to five times. This fits what we have known to be Viola triloba Schwein. and thus the Linnaean name preceeds and takes priority as the proper binomial for this violet. This leaves us with a homophyllous species where all leaves are cleft or parted into five to nine segments. A careful search through the literature found a match to this description in Viola subsinuata Greene (1898) which becomes the earliest and proper binomial for this species.

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HUCK, ROBIN B. Florida State Museum--Phytogeography of the endemic Labiates of the southeastern United States.

A number of endemic Labiates are found as small geographically isolated populations in the floras of Miocene, Pleistocene and Holocene dunes in the southeastern United States.

Species such as Calamintha ashei, C. coccinea, Conradina canescens, C. glabra, C. brevifolia, C. grandiflora, Dicerandra immaculata, D. frutescens, D. cornutissima, D. linearifolia, D. odoratissima, Piloblephis rigida and Scutellaria arenicola are apparently physiologically adapted to well-drained, sandy quartzipsamment soils and associated disturbed soils of these xeric habitats. Geographic isolation has probably played a major role in restricting the free exchange of genes in this group and, over time, this has led to genetic isolation and speciation. Recent studies of distributional patterns of these species and genera, coupled with the fact of the unusual mucilaginous hydrophilic fruit (myxospermy) of some of these genera, suggests a dispersal ecology correlative not only with the edaphics of dunes, but also with the streams and rivers which parallel those dune ridges. Water in streams and floods may have been the disseminating agent of the buoyant fruit. As pioneers and immigrants to disturbed sandy sites, these Labiate seeds would germinate, and as "founders", could establish new genetic lines. Endemic Labiates may be phytogeographic markers and clues to past immigration routes of the southeastern flora.

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COILE, NANCY C. University of Georgia. --SEM studies of Ceanothus seeds.
Ceanothus (Rhamnaceae), a North American genus of shrubs or small trees, consists of ca. 58 species, some 44 of which are endemic to California. Under study is an assemblage of three eastern species (C. americanus L., C. herbaceus Raf., C. microphyllus Michaux) and four western species [C. integerrimus Hooker & Arnold, C. martinii M.E. Jones, C. parvifolius (Watson) Trelease, and C. sanguineus Pursh] which seem closely allied based on similar morphological features of deciduous leaves, lack of spines and usually white flowers. SEM examination of seed coat features clearly separate species pairs which can be confused on morphological bases, especially in herbarium specimens.

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RETTIG, JEFF H. University of Georgia-- Foliar flavonoids of the Carex pensylvanica complex (Montanae, Cyperaceae).
The Carex pensylvanica Lam. complex (section Montanae) of North America consists of four closely related taxa: C. pensylvanica, C. lucorum Willd. ex Link, C. heliophila Mackenzie and C. inops L.H. Bailey. Recent taxonomic treatments of the complex do not agree in number or circumscription of the taxa. However, the four taxa can be distinguished based on their interspecific flavonoid complements which consist primarily of C-glycosylflavones and flavones, including isoorientin and the 7-O-glycosides of acacetin, chrysoeriol, luteolin, tricin, and 3',4',5'-trimethoxy tricin. These findings are corroborated by micromorphological features of the achene surface and macromorphological characters.

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BECKMANN, ROBERT L.[1] and GEORGE P. JOHNSON.[2] North Carolina State University[1] and Lindsey Wilson College[2]-- Contribution of flavonoid constituents to the taxonomic treatment of the chestnuts (Castanea).
Each species of Castanea produces a characteristic group of leaf flavonoids. Species in sect. Castanea (C. dentata, C. crenata, C. mollissima, C. sativa) and sect. Balanocastanon (C. pumila) contain flavonol glycosides and a single aglycone, quercetin. The flavonoid profile of C. X neglecta, a putative intersectional hybrid, reflects probable relationships of this taxon with both C. dentata and C. pumila. Castanea henryi (sect. Hypocastanon) shows greatest flavonoid homology with European and Asian representatives of sect. Castanea.

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WERTH, CHARLES R., A. MURRAY EVANS, and DONNA M.E. WARE. University of Kansas, University of Tennessee, and College of William and Mary. Orphans in the woods: new records for the hybrid Dryopteris x australis without its parents.

The Southern Hybrid Woodfern Dryopteris x australis (Wherry) Small is the aborted-spore hybrid of D. celsa (Palmer) Small, an allotetraploid species, with one of its parents D. ludoviciana (Kunze) Small. An interesting feature of this hybrid is that it occurs usually with only one of its parents D. celsa (which it closely resembles) well north of the range of the other parent D. ludoviciana. Recent examination of vigorous clones, initially identified as D. celsa, in southeastern Virginia and southeastern Tennessee has resulted in their reidentification as D. x australis based on morphology, aborted spores, chromosome counts, and isoenzyme profiles. Although both localities are within the range of D. celsa, the hybrids are several miles from the nearest known D. celsa plant, and much farther from the nearest known D. ludoviciana site. Three possible explanations for the occurrence of the hybrids can be advanced: 1) dispersal of spores of both parents to the site; 2) dispersal of D. ludoviciana spores into a D. celsa population followed by local extinction of D. celsa; 3) dispersal of unreduced viable spores of D. x australis resulting in apogamous sporophyte production. Evidence bearing on these hypotheses will be discussed.

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GARLAND, MARK A. Florida State University--The phenetic relationships of *Hieracium traillii* Greene, a shale-barren endemic.
Hieracium traillii Greene appears to occur only on shale slopes from Clinton County, Pennsylvania, south to Botetourt County, Virginia, and Greenbrier County, West Virginia. In 1922 the most recent reviser

of the genus grouped *H. traillii* with the other eastern North American species of subgenus *Stenotheca*. However, several other shale-barren endemics have their closest relatives in central or western North America, and there are several species of *Hieracium* in western North America to which *H. traillii* may be a sister species. *H. venosum* Linnaeus, widespread in forests of the Appalachian region; some plants of *H. megacephalon* Nash, endemic to Florida; *H. gracile* Hooker, of the Rocky Mountains and Sierra Nevada; and *H. traillii* all have basal rosettes that send up scapes branching into corymbs of fairly large heads. The closest relative of *H. traillii* may be one of these three species. In any case, *H. traillii* is diploid ($2n = 18$), as are all other North American members of subgenus *Stenotheca*, as far as known. In Keener's cytogenetic classification of shale-barren endemics *H. traillii* is thus a schizoendemic.

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JONES, SAMUEL B. AND NANCY C. COILE. The University of Georgia -- St. Catherines Island, Georgia: A Profile of Floristic Diversity as it Relates to Barrier Island Formation and Human Activities.

St. Catherines Island represents an undeveloped (in the modern sense) barrier island typical of the islands along the Georgia coast. Relative to the barrier islands of North Carolina or Mississippi, Georgia's barrier islands developed along a low energy coastline and are comprised of Pleistocene and Holocene coastal deposits dating back to ca. 40,000 to 25,000 years before present. Extensive salt marshes occur between the islands and the mainland. Human activities have had a major impact on the flora of all the islands. Pre-agriculture American Indians arrived ca. 2200 BC and the mixed agriculture hunting/gathering culture ca. AD 1150. European contact and settlement occurred over 500 years ago. Fire, agriculture, lumbering, grazing, and feral animals have all impacted upon the flora and plant communities of St. Catherines Island. A floristic survey extending over three growing seasons was conducted as part of a multidiscipline analysis of St. Catherines Island. An overview of the physical, vegetational, and cultural features of the islands will be presented and the flora will be compared to that found on other barrier islands.

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METHVEN, ANDREW S. University of Tennessee--The genus Clavariadelphus (Basidiomycetes, Aphyllophorales) in North America, excluding Mexico.

The genus Clavariadelphus was proposed by Donk to segregate taxa with simple, clavate, smooth to rugulose basidiocarps with rounded or truncate apices, chiastic, four-spored basidia, and smooth, colorless, ellipsoid basidiospores from the genus Clavaria sensu Fries. In light of its potential phylogenetic importance, recent advances in the taxonomy of the clavarioid fungi, changes in the rules of botanical nomenclature, and a broader acceptance of the systematic value of beta-taxonomic characters, a systematic re-evaluation of the genus Clavariadelphus in North America has been completed. A critical microscopic examination of herbarium specimens from Europe and North America was conducted in order to re-evaluate the taxonomic value of micromorphological characteristics within the genus Clavariadelphus. As a result of this study, type specimens have been selected for three European and one North American taxa and the taxonomic criteria for the delimitation of taxa within Clavariadelphus has been established. A subgeneric classification of the genus Clavariadelphus will be presented along with distributional maps of the North American taxa and their salient macro- and micro-morphological characteristics. In addition to the re-evaluation of macro- and micro-morphological characters used in classical fungal systematics, the results of macrochemical color reactions and the chemotaxonomic distribution of pistillarin in the basidiocarps of Clavariadelphus and their potential taxonomic value in the systematic rearrangement of the genus Clavariadelphus will be presented.

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RIPLEY, BRUCE, DOSHIA WEBB, H. WAYNE ELMORE and ALAN R. WHITE. Marshall University--A sustainable cell suspension culture derived from Bracken Fern root callus.

A rapidly-growing callus culture was established from roots of the Bracken Fern, Pteridium aquilinum, on solid Knudson's medium containing 2% sucrose, 2 ppm 2,4-D, 0.2 ppm kinetin, 5 ppm ascorbic acid and 1.2% agar. Liquid medium of the same composition lacking agar was used in an effort to establish a cell suspension culture without success. Growth was dramatically increased on Knudson's medium supplemented with 10% coconut milk. Attempts to develop a defined medium without coconut milk have centered around studies on the affects of combinations of mixtures of six vitamins, six cytokinins and casein hydrolysate. Casein hydrolysate is the most important factor. The culture is now maintained at 23°C in darkness on a shaker at 175 rpm in 0.5 or 2.0 l Wheaton shake flasks containing Knudson's medium supplemented with 2% sucrose, 5 ppm ascorbic acid, 2 ppm 2,4-D, 100 ppm inositol and 10 ppm casein hydrolysate. Cultures are subcultured at 14-day intervals. Growth increases several hundred percent over a 2-3 week experimental period. As far as authors are aware this is the first report of a sustainable fern cell suspension culture.

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GILL, JAMES P., CHERYL E. WILLIAMS, MARK B. WATSON, ALAN R. WHITE, H. WAYNE ELMORE. Marshall University--Polysaccharides in coconut milk.

The addition of coconut endosperm (coconut milk) has been found to enhance cell growth in plant tissue cultures. We are using liquid suspension culture cells for analysis of cell wall polysaccharides. Any existing polysaccharides must first be removed from added coconut milk to prevent contamination of the liquid culture medium. This was accomplished by filtering the coconut milk, followed by precipitation twice with 70% ethanol, centrifugation, and lyophilization of the resulting pellets. This material was resuspended in water; only 10% was soluble. The soluble fraction was then separated using A-5M, A-0.5M, and P-10 gel filtration chromatography columns. Amounts of neutral sugars and uronic acids were determined colorometrically using the anthrone and m-phenylphenol methods. Carbohydrate composition was determined by GC analysis using the alditol acetates procedure. A large peak running at the void volume of the A-0.5M column and near the void volume of the A-5M column was the major component and contained: 72% Galactose, 24% Arabinose, 2% Glucose, and 2% Rhamnose. Uronic acids were also present in the fraction.

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TANNENBAUM, MICHAEL G.[1], E. BOWIE KAHLE[1], and RUSSEL J. REITER[2]. [1]Marshall University and [2]University of Texas Health Science Center at San Antonio--Effect of acute cold exposure on pineal biosynthetic function in rats.

In the mammalian pineal, melatonin synthesis is inhibited by daylight, but increases to peak levels during darkness. Several environmental stressors may modulate this normal day:night rhythm by inhibiting the expected darkness-induced rise in pineal melatonin levels, or in the activity of N-acetyltransferase (NAT), the rate-limiting enzyme in the melatonin synthetic pathway. We assessed the effect of acute cold exposure (2°C) on melatonin production in the rat pineal at night. In a preliminary experiment, radioimmunoassay was used to measure melatonin and NAT in rats held in individual cages at 2°C for 1/2, 1, or 2 hr. Thirty minutes of cold exposure had no effect on the rat pineal. Compared to room temperature controls killed at Time Zero, rats killed after 1 hr of cold displayed significantly higher melatonin levels, with no increase in NAT activity. By 2 hr, melatonin had returned to control values. These data suggest that cold exposure may act through a different mechanism than do other stressors, which tend to depress melatonin content or NAT activity at night. A second experiment, currently underway, will more closely follow the time course of enhancement of melatonin production. Furthermore, HPLC will be used to measure plasma catecholamines as an indication of stress levels in experimental vs. control animals.

Supported by NSF grant #PCM 8410392 to RJR

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CHEN, DILLION T. and L. FREDERICK. Howard University--Anatomical studies on phyllotaxy in young seedlings of the American elm (Ulmus americana).

During the early stages of seedling development in the American elm, the first pair of true leaves, and leaves at the next two or three succeeding nodes, appear to be oppositely arranged. Thereafter, later developing leaves have a clearly discernible alternate pattern, the type of phyllotaxy that distinguishes the species. To investigate the transition from a putative opposite leaf arrangement in young elm seedlings to an alternate pattern, anatomical studies on the first two or three nodes immediately above the cotyledonary leaves have been conducted. These studies reveal that leaf phyllotaxy at these nodes is not truly opposite. Instead, anatomical observations in the nodal region where the first pair of true leaves occur show that the leaf trace supply for each of these leaves departs from the stele at slightly different topographic levels. The first pair of true leaves do not share a common node. The vertical distance between the two nodes is minimal, however, and is not discernible in the intact seedling. Cell elongation in the region between the first two nodes is slight and causes the leaves to appear to be oppositely arranged. As subsequent leaves form, elongation in the internodal region increases and a discernible alternate phyllotaxy becomes evident.

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SHERROD, K. C., THOMAS G. CIRAVOLO, and KENNETH W. McLEOD. Savannah River Ecology Laboratory/University of Georgia--Growth of woody seedlings under varying light conditions.

Forest succession indicates that species replacement should be affected by the relative shade tolerances of species. In flooded habitats, the successional sequence must also be controlled by their flood tolerance. Growth of four colonizing woody species, which are all flood tolerant, were examined in artificial environments of different light intensities. Taxodium distichum, Nyssa aquatica, Salix nigra, and Cephalanthus occidentalis seedlings were germinated and grown under 100%, 50%, 25% and 15% full sun. Height and diameter were measured bi-weekly to determine the growth pattern of these species. Biomass was determined at four times during the growing season. Water tupelo, black willow and button bush grew best in 50% sun, whereas bald cypress tended to grow better in 100% sun. Growth form of button bush, water tupelo and bald cypress seedlings was unchanged. However, black willow seedlings tended to branch more as the light intensity increased. The growth response indicated that successful re-establishment may be promoted by environments with up to 50% shade due to the increased growth. Thus, while these species are generally shade intolerant, the increased exposure to full sunlight does not necessarily promote the greatest growth.

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NOVAK, JAMES M. Savannah River Ecology Laboratory -- Heterozygosity and sample sizes in population genetic studies of vertebrates.

Population estimates of multi-locus direct count heterozygosity are often used as a sample statistic in population genetic studies. Previous studies have suggested that the number of loci is more important than the number of individuals sampled, especially for systematic studies. To more fully investigate this problem, Monte-Carlo simulation techniques were employed using data sets from five vertebrate species: White-tailed deer (N=956, L=18, H=0.1958), hispid cotton rat (N=124, L=37, H=0.0379), wild turkey (N=75, L=29, H=0.0308), red-cockaded woodpecker (N=104, L=18, H=0.0769), and mosquitofish (N=1569, L=17, H=0.1182). Simulations were conducted with initial sample sizes of one individual and proceeded up to the maximum N. For each sample size 250 iterations were run. Random sampling was conducted without replacement within an iteration and with replacement between iterations. The mean value for all iterations within a sample size did not vary significantly from that obtained using the full sample. However, this does not reflect the situation in a real field study since it is unlikely that an investigator would sample a population 250 times in a time span short enough to preclude significant genetic variation. The coefficient of variation at each sample size reflects the ability of a single study to adequately estimate direct count heterozygosity using the indicated sample size. Reduction of the coefficient of variation to the 5% level requires 60-70 individuals/population for the homeothermic species and 100 individuals/population for mosquitofish. This is 50-150% larger than the previously "accepted" value of 40 individuals/population.

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BRATTON, SUSAN P. US National Park Service Cooperative Studies Unit, University of Georgia--Impacts of experimental poaching on pink lady slipper, Cypripedium acaule, and on common wood violet, Viola papilionacea.

Experimental plots were established at Coweeta Hydrologic Laboratory, NC, in April and May 1985. Of sixteen 2 x 2 m plots containing violets, all violets were removed from four, all flowering violets were removed from four, all violet inflorescences were removed from four, and four were left as controls. Of twelve 10 x 10 m plots containing pink lady slippers, four had the shrub layer removed by cutting at ground level. Of these plots, all flowering plants were removed from two by digging, and the other two remained as controls. Of the eight plots with shrub layer intact, all flowering plants were dug from four. Treatments were repeated in May 1986. The first year's response indicates removal of inflorescences did not restrict blooming of violets the following year, although removal of blooming plants does cause a decline. Numerous seedlings established in cleared plots. Prior to harvest of blooming plants in 1985, pink lady slippers in control plots had 94% the number of flowers of lady slippers in "poached" plots. Prior to harvest in 1986, control plots had 354% of the number of flowers in "poached" plots. Release of the herb layer through removal of the shrub layer had no detectable effect.

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LYDEARD, CHARLES and MICHAEL L. KENNEDY. Memphis State University--Morphologic assessment of the coyote, Canis latrans, in Tennessee.

Recently founded populations of the coyote (Canis latrans) in Tennessee were assessed morphologically using multivariate statistical procedures. Five pelage and 20 cranial measurements were used in the examination. Results verified C. l. frustror and C. l. thamnos as valid subspecies and indicated the presence of both taxa in Tennessee. These findings suggested a multiple origin for coyote populations in the newly colonized area. However, since C. l. frustror was the predominant subspecies in the state, it appeared that Tennessee coyotes have a greater affinity with C. l. frustror than C. l. thamnos. Spatial variation existed among the populations sampled which included specimens from newly colonized areas in Tennessee and established portions of the range. This study provided little evidence to suggest a discrete morphologic form as the founder of the newly founded populations or the disperser into Tennessee.

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PRINS, RUDOLPH and RODNEY MCCURRY. Western Kentucky University--Morphology of the male gonopod of freshwater asellid isopods.

The armature of the endopodial tip of the male second pleopod of asellid freshwater isopods is emphasized in taxonomic works, although nomenclatural terms are not used consistently. Furthermore, the precise anatomy of this structure is not to be found in the literature and not well understood. Consequently, undue emphasis on homologous relationships may be premature. This study shows some of the nomenclature problems and makes comparisons of endopods of several species, including Caecidotea brevicauda, C. forbesi, C. intermedius, C. stygia and C. meisterae using both S.E.M. and traditional methods.

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KELLY, MARY SAULS. University of Georgia Savannah River Ecology Laboratory--*Leaf production and turnover in three co-occurring species of floating-leaved macrophytes*.

As part of a larger study to assess the role of macrophytes on the ^{137}Cs cycle in Pond B, Savannah River Plant, SC, leaf production and turnover were measured throughout the 1986 growing season for *Brasenia schreberi*, *Nymphaea odorata* and *Nymphoides cordatum*. Floating leaves were individually marked as they emerged and monitored weekly for senescence and herbivory in six 0.25-0.5 m^2 plots arranged in paired near-shore and mid-littoral locations. Average life-spans for leaves of *Brasenia*, *Nymphaea* and *Nymphoides* were 27.6, 36.2 and 15.0 days, respectively. New leaf and petiole production rates averaged .278, .175 and .428 week^{-1} for *Brasenia* *Nymphaea* and *Nymphoides*. Leaf cohort life-spans were similar throughout the growing season for *Nymphoides*, but ranged from lows of 26 and 30 days in June to highs of 37 and 50 days in September for *Brasenia* and *Nymphaea*. Cohort life-spans were generally slightly longer in shallow plots for *Brasenia* and *Nymphaea*. Grazing by the Chrysomelid beetle *Pyrrhalta nymphaeae* was locally and seasonally severe, especially on *Brasenia*. Relationships between herbivory and leaf life span will be discussed. Constant leaf production and senescence throughout a long (ca.275 days) growing season results in a high number of annual turnovers for above-sediment biomass in these species: 5-7, 6.5 and 15.6 for *Brasenia*, *Nymphaea* and *Nymphoides*. Leaf and petiole biomass of these 3 species represents 70-80% of the abundant above-sediment biomass in Pond B. Production estimates which do not account for turnover may underestimate by ten-fold the importance of these species to aquatic systems in which they are dominant.

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DEBIASE, ADRIENNE E., ROBERT W. SANDERS, and KAREN G. PORTER. University of Georgia--*The impact of net zooplankton on bacteria-size particles in a monomictic lake.*

In situ feeding studies were done on the net zooplankton of Lake Oglethorpe, Georgia. Tracer amounts of bacteria-size (0.57 micron) polystyrene microspheres were introduced to whole lake water, and ingestion rates of the microspheres were determined using epifluorescence microscopy and flow cytometry. Estimates of bactivory were calculated from filtration rates on the microspheres. Cladocerans had the highest ingestion rates, followed by rotifers. No ingestion was seen by copepods, nauplii, ostracods or *Chaoborus*. Ingestion rates varied seasonally and with depth. The relative impact of each group on the bacterial population of Lake Oglethorpe depended on the group's abundance.

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HUNSINGER, RONALD N., BARRY BYRAM, and W. MIKE HOWELL. Samford University--*Gonadal morphology in mosquitofish exposed to degraded plant sterols*.

It has recently been shown that female mosquitofish, *Gambusia affinis affinis*, can be externally masculinized by subacute exposure to degraded plant sterols. The purpose of this study was to further characterize this masculinization effect with respect to internal anatomy. No alterations in gross or microscopic anatomy of gonadal or liver tissues were evident in externally well-masculinized female Gambusia. Likewise, when male Gambusia were subjected to similar sterol exposures, no gonadal changes were noted. Potential mechanisms for this selective external effect are discussed.

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WEBB, DOSHIA, BRUCE RIPLEY, H. WAYNE ELMORE and ALAN WHITE. Marshall University--*Factors Influencing Growth and Regeneration in Bracken Fern Root Callus*

Tissue cultures were established by transferring roots of axenically cultured sporophytes of the Bracken Fern, *Pteridium aquilinum* (L.) Kuhn var. Latiusculum to Knudson's medium containing 2% sucrose, 2.0 ppm 2,4-D and 0.2 ppm kinetin in darkness. Approximately 100 isolates of callus were subcultured. Most of the callus lines were slow-growing and dark brown in color. One rapidly-growing clone was selected for study. A series of experiments was completed to determine in effects of antioxidants including polyvinylpyrrolidone, L-ascorbic acid, L-cysteine HCl, glutathione and sodium selenite on growth and browning. All of the antioxidants stimulate growth with the exception of glutathrone which was inhibitory. The results suggest that phenolic production and possibly other oxidative processes reduce growth. The callus is now routinely subcultured on medium containing 5.0 ppm ascorbic acid. Experiments were conducted on the regeneration of root callus. Pieces of callus were transferred to medium containing 0-4% sucrose without 2,4-D, kinetin or ascorbic acid. Gametophytes regenerated in large numbers from callus grown on 0% sucrose. Concentrations above 1.0% resulted only in extensive dark brown callus growth. The callus consisted of undifferentiated spherical-eliptical cells parenchyma cells. Sucrose exerts a marked influence on the developmental pattern and is the key factor in controlling the regeneration of gametophytes from sporophytic root callus.

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TURNER, ALAN E. and DONALD C. TARTER. Marshall University--The effect of intermittent oilfield brine influences on benthic macroinvertebrate community structure in two headwater streams of the Pocatalico River, West Virginia.

The Pocatalico River is a major tributary of the Kanawha River in central West Virginia. Its headwaters receive intermittent contributions of brine from a variety of sources related to the secondary oil and gas production within the Walton oil and gas field. The benthic macroinvertebrates of two of these headwater streams proved to be limited in total numbers, taxa and diversity with increasing brine concentrations as compared to a clean water tributary that was monitored as a control. Brine concentrations of two monthly samples from one of the affected streams exceeded concentrations previously considered to be toxic by acute toxicity testing. Discriminant analysis and Ecological Community Analysis identified dominant and limiting factors affecting community development from various chemical and physical parameters monitored at these three streams.

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SERA, WENDY E., C. H. GREENBERG AND PATRICIA D. PARR. Earlham College, University of Tennessee, and Oak Ridge National Laboratory--Diet of the gray fox (Urocyon cinereoargenteus) and small mammal availability on the Oak Ridge National Environmental Research Park.

In the southeastern United States, the gray fox is found primarily in mixed hardwood forests and in disturbed or open areas. Its spring and summer diet consists primarily of plant material; in the winter its main diet component is animal matter. Several studies indicate that primary prey includes rabbits and rodents. We surveyed the composition and relative abundance of the small mammal populations in four gray fox habitats on the Oak Ridge National Environmental Research Park in east Tennessee. Old-field and hardwood communities contained a greater proportion of small mammals than did the immature and mature pine plantations. Peromyscus leucopus, white-footed mouse, and Cryptotis parva, least shrew, were the most abundant species captured. Scat analysis indicated that plant matter eaten in the fall consisted primarily of persimmon fruit, with only a small proportion of insects, other plant material and small mammals. The presence of such items indicates the opportunistic nature of the gray fox. As fruits become less available, a shift in diet to small mammals is expected later in the season. Research sponsored by the Office of Health and Environmental Research, U.S. Department of Energy, under contract No. DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

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GIPE, TODD G. and JOHN G. MORRIS, Florida Institute of Technology--Effects of prescribed burning on the suitability of habitat for the Florida scrub jay, Aphelocoma coerulescens coerulescens.

A prescribed burn program for Merritt Island National Wildlife Refuge, Brevard Co., FL, was evaluated in terms of its effect on quality of habitat for Florida scrub jays. Twenty-seven plots were chosen in known jay habitats of the coastal scrub and flatwoods communities. Scrub jay density was measured in each area using the variable circular-plot census technique, supplemented with the spot-map method. Vegetational parameters (density by species, cover by species, and heterogeneity indices) were measured in eight of the plots, representing five habitat regrowth stages. Jay densities determined by the circular-plot method did not compare well with those determined by the mapping method. The circular-plot method yielded several values that did not accurately correspond to the number of jays in the area, so the mapping method values were used in the comparisons with various habitat measures. These densities ranged from zero to 31.08 birds per 40 hectares, with mean of 11.02 (S=7.22). Scrub jay density correlated positively with: distance to nearest hammock, cover of sand live oak, saw palmetto, and yaupon holly; and negatively with: percentage of swale, density of shiny lyonia, and total density of non-quercine species. No simple evaluation of the effect of prescribed burning on suitability of habitat was possible; jay density seems to be more affected by the vegetational structure and composition of the individual sites.

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GETTINGER, RONALD D. and WILLIAM H. N. GUTZKE. University of Alabama at Birmingham and Memphis State University-- Influence of hydric environment on growth and metabolism of embryonic painted turtles.

Turtle eggs are known to exchange water with their environment during incubation. Net water exchange is determined in part by eggshell structure: eggs of species producing pliable eggshells display greater flux rates than do eggs of species producing rigid eggshells. Hydric conditions can also influence water flux. We examined the effects of hydric conditions during incubation on (1) water exchange by the eggs, and (2) oxygen consumption and growth of the embryos within those eggs. Freshly oviposited eggs of the painted turtle, Chrysemys picta , which produces pliable-shelled eggs, were incubated to hatching on substrates differing in water potential. On wetter substrates, eggs gained mass for the first half of incubation then stabilized, while eggs on drier substrates lost mass. From midway through incubation and continuing to hatching, embryos within eggs on wetter substrates were larger and contained more water than embryos from eggs on drier substrates. Time to hatching was also greater for embryos developing within eggs on wetter substrates. Mass-specific oxygen consumption of embryos was not affected by treatment. In natural nests eggs are exposed to a range of hydric conditions. The larger size and greater degree of hydration of hatchlings from more hydrated eggs may enhance survival.

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DINDO, JOHN J. AND KEN R. MARION. Dauphin Island Sea Lab, and University of Alabama at Birmingham. The influence of a major weather event on Cat Island, Alabama, a coastal heronry.
Cat Island is a 5.2 (ha.) island in which over three thousand herons, egrets and ibis nest. This island has the largest assemblage of Tricolor herons (Hyranasa tricolor) in Alabama. In the fall of 1985 hurricane Elena, Juan and Kate battered our coastline, reducing the nesting vegetation (Iva frutesans and Baccharis halimofolia) from an average height of seven feet to little more than two feet. The storms hit late enough in the year that most fledglings had already left the nesting sites. The total number of birds nesting in 1986 breeding cycle was reduced by approximately 10-15%. The lack of suitable nesting sites is believed to be the reason. Nesting success for the Tricolor Heron and the Snowy Egrets were 59% and 56%, respectively as compared to 79.8% and 70% for the 1985 season. The lack of spring floods and fall storms in 1985 increased the nesting success for that year. As a result of the hurricanes the nests were built with very little vegetative coverage over them. This enhanced predation of eggs and young by fish crows. The inland pond on Cat Island which was flooded daily through a deep tidal creek was closed after the hurricanes and a more shallow tidal creek was established four months later in February. The loss of volume exchange to this area is believed to have reduced the readily available food resources (fish) used by the adults and may have contributed to the numerous fledgling deaths observed.

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COLEMAN, SUSAN A., J VAUN MCARTHUR, AND LAURA G. LEFF. Savannah River Ecology Laboratory--Comparison of the decomposition of autumn and summer shed Acer rubrum in a coastal stream.
The decomposition of green and autumn shed Acer rubrum (red maple) leaves was compared in a coastal plain stream on the Savannah River Plant. Because green leaves initially have higher concentrations of nutrients they were expected to be processed more rapidly. In addition to processing rates, microbial density and number and types of invertebrates were also examined. During the initial phase of decomposition, green leaves were processed at a slightly slower rate (0.012 vs 0.041 g/day). Leaching losses were greater for green leaves (14.1% vs 12.9%). Many factors including nutrient concentration may influence decomposition rate. Other variables such as microbial conditioning, invertebrate community structure, thermal regime, and timing of input may interact to determine specific breakdown rates.

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OLIVER, JAMES R. and ROBERT A. STILES. Samford University--Reproductive biology of the Cahaba shiner, Notropis sp., in the Cahaba River drainage, Alabama.
The reproduction of the Cahaba shiner, Notropis sp., was studied using collections taken from the Cahaba River drainage, Alabama between 1982 and 1986. Reproduction occurred from late April-late July; however, gross examination of the reproductive condition of females showed that most females were reproductive from early May-mid June. All females were sexually mature by 36 mm standard length (SL); and by 37 mm SL, all males were mature. The number of mature ova in 11 females 36.4-49.4 mm SL ranged from 52-280 and was significantly correlated with female size. Mean mature ovum diameter in 10 females ranged from .68 -.95 mm ($\bar{x}$=.81±.06 mm). There was no significant correlation between mean female ovum diameter and SL. Maturity is reached in a year.

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P.M. Zavos, D.R. Varney, L.P. Bush, R.W. Hemken, J.A. Jackson and M.R. Siegel. University of Kentucky--Reproductive responses in male rats fed extracts of fescue seed infected by endophytic fungus (Acremonium coenophialum).
This study was undertaken to determine whether a serial methal extraction of endophyte infected fescue seed contained the factor(s) in that seed that were responsible for the decrease in male reproductive potential as reported earlier by this group. Twenty-four Sprague-Dawley male rats (ca.225 g.) were randoomly assigned to one of three dietary treatments containing 50% (w/w) rodent chow and 50%: (1) noninfected tall fescue seed; (2) noninfected tall fescue seed treated with concentrated methanol effluent from serial methanol extraction of infected seed; and (3) the seed residue (G1-307) of seed that was >95% infected by Acremonium coenophialum. Parameters assessed were testicular weight, epidydimal weight, parenchymal weight, progressive sperm motility, sperm motility, sperm count and daily sperm production potential. The data were analysed by variance techniques using the General Linear Models procedure of the Statistical Analysis System. The results showed significant reductions (P<0.05) in Treatment 2 for feed intake, average daily gain, testicular weight, epidydimal weight and daily sperm production potential. These data suggest that the serial methanol

extraction contains the factor(s) responsible for lowered reproductive potential in male rats. The extract contains 15,578 mg/ml of pyrrolizidine alkaloids and only trace amounts of ergopeptides. This suggests that ergopeptides would be extremely active in this bioassay or that they have a minor causative role in this bioassay. These results indicate that N-formyl and N-acetyl loline may play an important role in fescue toxicity.

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Zavos, P.M., D.R. Varney, J.A. Jackson, R.W. Hemken, M.R. Siegel and L.P. Bush. University of Kentucky--Embryonic and fetal development in CD-1 mice fed endophyte infected tall fescue seed.

The objective of this study was to assess the effects of endophyte-infected tall fescue (KY-31) seed (80% infected, containing *Acremonium coenophialum*) on the ovulation rate and embryonic development in CD-1 mice. Twenty-four pairs of mature CD-1 mice were randomly allocated to two dietary treatments containing 40% mouse chow and (1) 60% non-infected tall fescue seed; (2) 60% infected tall fescue seed (w/w). The mice were preconditioned on their respective diets for 60 days prior to 96 hours of cohabitation between pairs of males and females. Following the removal of the males equal numbers of females (n=4) from each dietary treatment were sacrificed at 80 hours, 6 and 10 days post-vaginal plug establishment. The female reproductive tracts were excised and flushed to recover eggs and embryos or dissected to identify the number and status of the implanted fetuses. The number of eggs-embryos and/or fetuses per mouse present among the sacrifice time intervals were 9.8, 8.8 and 11.5 *vs* 8.2, 5.3 and 4.8 between the mice fed the non-infected and infected fescue seeds, respectively. Similarly, the conception rates (%) were: 100, 100 and 100 *vs* 73, 50 and 50 for the two treatments. For the mice sacrificed at 80 hours and fed the non-infected fescue had 9.8 expanded blastocysts per animal, where in mice fed the infected fescue had only 4.0 expanded blastocysts. The results tend to suggest that the infected fescue seed consumed by these mice had a significant effect on their embryonic and fetal development. More importantly, the infected fescue seed influenced negatively the development of these embryos during the embryonic-pre-implantation period.

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P.M. Zavos, D.R. Varney, J.A. Jackson, R.W. Hemken, M.R. Siegel and L.P. Bush. University of Kentucky--Lactation in mice fed endophyte infected tall fescue seed.

This study was conducted to assess the effects of endophyte-infected tall fescue (KY-31) seed (80% infected, containing *Acremonium coenophialum*) on lactation in CD-1 mice dams and suckling performance of pups as measured by pup survival and growth rates. Twenty-four pairs of mature CD-1 mice were randomly allocated to four dietary treatments: (1) 100% mouse chow *ad libitum*; (2) 40% endophyte-infected tall fescue seed and 60% mouse chow (w/w); (3) reduced intake (100% chow), adjusted daily to the intake level of Treatment 2; and (4) 60% infected tall fescue seed and 40% chow. The mice were preconditioned on their respective diets for 100 days prior to 96 hours of cohabitation between pairs of males and females. At parturition the litters were removed and each dam was given a litter of six pups of equal weight, size and sex ratio, to suckle for 15 days. All pups given to all the dams were born to other mice that were not on the study and were not exposed to endophyte containing diets. Dam and litter weights were measured daily for 15 consecutive days. The combined body weight measurements of litters from dams fed the tall fescue containing diets (2 and 4) were significantly lower by 2.07±0.41 g/day than that of litters from dams fed the chow containing diets (1 and 3) during the suckling trial ($P<.05$). Similarly, nine of ten (90%) dams fed the chow containing diets maintained five or more pups (5.5±0.2) throughout the study as compared to five of nine (55.6%) dams fed the tall fescue containing diets that maintained less than five pups (4.5±0.2).

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Oakley, William E. and Gerhard W. Kalmus. East Carolina University--Effects of oxidizing agents on flour beetle larvae.

The common flour beetle, *Tribolium confusum*, was utilized as an invertebrate model to test the insecticidal potential of benzoyl peroxide, an oxidizing agent used in the preservation of flour. Diflubenzuron, a known chitin synthesis inhibitor which has a chemical composition similar to benzoyl peroxide, was used as our control Progressive developmental stages of *T. confusum* were exposed to flour which was previously treated with each benzoyl derivative. The flour was treated with a series of chemical concentrations ranging from 0.01 to 100 ppm. Results indicated that fecundity decreased, larval weight decreased, mortality rates increased. A chitin dry weight measurement showed a drop in overall chitin deposition. Electrophoresis indicated a drop in total pro tein concentrations in treated larvae. Total protein and glucose assays showed decreases and histological examination also indicated smaller quantities of chitin were being deposited in the exoskeletons. Both treatments had similar effects. Thus, this data indicates that oxidizing agents used in flour do have adverse effects on the development of flour beetle larvae.

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REED, ALAN W. and JOE E. WINSTEAD. Lindsey Wilson College, and Western Kentucky University--The sex life of flowers.

Pre-recorded audio, color slides, and videotape are integrated into a videotape presentation explaining the structure and adaptive mechanisms of angiosperm flowers, modes of pollination, double fertilization, and seed dispersal. A 3/4 inch videotape recorder, editor, character generator, 35 mm camera, and audio mixing equipment were utilized in the production process. This project indicates that readily available technology can be used in this manner to more effectively integrate lecture and laboratory sessions covering the largest class of land plants.

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ASB CANDIDATES FOR OFFICE—1987

The Nominating Committee composed of Rudolph Prins, James W. Hardin, and Chairman J. Charles O'Kelley has selected the following slate of nominees for the ASB offices to be filled this year. Additional nominations will be received from the floor. Voting will take place at the Annual Business Meeting at 11:45 A.M. Friday, 10 April 1987. Please plan to attend.

President-Elect: **Courtney T. Hackney**, Univ. of North Carolina–Wilmington
William T. Martin, Eastern Kentucky University, Richmond
Vice-President: ***Carol G. Baskin***, Univ. of Kentucky, Lexington
Charles H. Nelson, Univ. of Tennessee, Chattanooga
Executive Committee: (Two positions) **Richard Lee Buckner**, Livingston Univ., Alabama
J. Whitfield Gibbons, Univ. of Georgia, Savannah River Ecology Laboratory
George C. Murphy, Middle Tennessee Univ., Murfreesboro
Diane R. Nelson, Tennessee State Univ., Johnson City

PRESIDENT-ELECT

Courtney Hackney

William Martin

Courtney T. Hackney—Courtney T. Hackney received his B.S. in Biology from the University of South Alabama, his M.S. in Biology from Emory University, and his doctorate in Zoology from Mississippi State University. His research interests are Coastal Biology and Ecology. He has conducted research on the Atlantic, Gulf, and Pacific coasts of the United States. Courtney's research papers have covered a wide range of topics including: plant communities' response to fire, taxonomy of intertidal invertebrates, estuarine fish community structure, and energetics of salt marshes. Courtney has served on various ASB committees and is currently completing a term on the Executive Committee

(1984–87). In addition, he has served as Vice-Chairperson of the Southeastern Section of the Ecological Society (1985–87), Vice President (1985–86) and President (1986–87) of the Society of Wetland Scientists, Associate Editor of ESTUARIES (1978–83), and he is presently on the Editorial Board of WETLANDS. He served as Program Committee Chairperson for three national meetings of the Society of Wetland Scientists and for the 1979 Gulf Estuarine Society Meeting. Currently, Courtney is an Associate Professor of Biological Sciences at the University of North Carolina at Wilmington. He has directed five M.S. students as well as Honors students.

William H. Martin—Dr. Martin is Director of the Division of Natural Areas and Professor of Biology at Eastern Kentucky University, Richmond, Kentucky. He received the B.S. degree (1960) from Tennessee Technological University, and the M.S. (1966) and Ph.D. (1971) degrees in Botany from The University of Tennessee–Knoxville. As division director, he is responsible for the management and development of the University's three off-campus natural areas as well as coordinating the research, instructional, and public programs at each site. In addition to these administrative duties, he teaches courses in community ecology, agrostology, and environmental ethics. Dr. Martin's research interests are in community ecology with emphasis on deciduous forest and grassland ecosystems. For several years, he has concentrated on long-term research projects related to mixed mesophytic forest structure and dynamics in the Kentucky portion of the Appalachian Plateau. In western and central Kentucky, he is involved in research and management/restoration projects of wetlands and native grasslands. He is active in Kentucky conservation matters, having served as a Science Advisor to the Kentucky Nature Preserves Commission and as an officer and Trustee of the Kentucky Chapter of The Nature Conservancy. He is a recipient of the Wildlife Conservationist of the Year Award (1977) given by the League of Kentucky Sportsmen. Dr. Martin is a member of AAAS, AIBS, Sigma Xi, and the Tennessee and Kentucky Academies of Science, has chaired the Botany Sections in both state academies, and is a Fellow of the Tennessee Academy of Science. A member of the Ecological Society of America, he is on the Education Committee and a former officer of the Southeastern Chapter (Secretary-Treasurer, 1980–82). He is the Chair of the Editorial Board of BIOTIC COMMUNITIES OF THE SOUTHEASTERN UNITED STATES, a 2-volume publication now in preparation by southeastern ecologists and sponsored by the SE/ESA. He is the immediate Past-President of the Southern Appalachian Botanical Club. Dr. Martin has been an active member of ASB since graduate school, regularly presenting papers in the plant ecology sessions and participating in ecological symposia at annual meetings. Service to the Association includes a term on the Conservation Committee (1979–82), Local Arrangements Chair (1982 Meeting), and at-large member of the Executive Committee (1983–86). He is the current Vice-President of ASB.

VICE-PRESIDENT

Carol C. Baskin—Dr. Baskin is an Adjunct Associate Professor of Biological Sciences at the University of Kentucky. She received a B.S. (1964) degree from Florida Southern College and a Ph.D. (1968) degree from Vanderbilt University. Research efforts are mainly concerned with the autecology of endemics of rock outcrops of unglaciated eastern United States (especially the cedar glades) and with the life cycles of herbaceous plants, with particular emphasis on seed germination ecology. Dr. Baskin has been a member of ASB since 1966 and has served as Secretary (1979–82) and as a member of the Executive Committee (1984–87). She also is a member of the Ecological Society of America, serving as a member of the Finance Committee, 1979–81; Botanical Society of America, serving as Secretary, 1980–84, and the Torrey Botanical Club.

Charles H. Nelson—Dr. Nelson is Professor and Head of the Department of Biology at the University of Tennessee at Chattanooga. He received his B.S. degree in Zoology (1963), and M.S. (1967) and Ph.D. (1969) degrees in Entomology from the University of Massachusetts, Amherst. Dr. Nelson's research interests have involved studies in the systematics, morphology, and ecology of the aquatic insect order Plecoptera. His current interest involves the application of cladistic techniques in constructing computer-generated estimates of phylogenetic relationships. At The University of Tennessee at Chattanooga Dr. Nelson has served on a number of committees and organizations including President of the university's scholastic honor society. Recently he was elected to The University of Tenneseee at Chattanooga Council of Scholars 'in recognition of scholarly achievement'. Besides membership in ASB, Dr. Nelson is a member of numerous other scientific societies including the Entomological Society of America, Society of Systematic Zoology, The American Society of Plant Taxonomists, American Entomological Society, Kansas Entomological Society, Pacific Coast Entomological Society, Entomological Society of Washington, Willi Hennig Society, Sigma Xi, and Tennessee Academy of Science (Elected a Fellow, 1979).

EXECUTIVE COMMITTEE

Richard Lee Buckner—Associate Professor of Biology at Livingston University, Livingston, Alabama. He received the B.S. (1970) and M.S. (1972) in Biology from Western Kentucky University and the Ph.D. (1976) in Zoology from The University of Nebraska, Lincoln. He was Visiting Assistant Professor of Biology at Indiana State University, Evansville from 1976–78. Since 1978, he has been at Livingston University. He teaches courses in the areas of invertebate zoology, ecology, physiology, and environmental science. His research interests are the biology and taxonomy of parasitic helminths, especially the Acanthocephala. He has published numerous articles in refereed journals. Dr. Buckner has been a member of ASB for 15 years. He regularly attends ASB meetings and has served on the Student Awards Committee (Chairman, 1986). Dr. Buckner is a member of several national scientific societies, including the American Society of Parasitologists and the Helminthological Society of Washington, and several state and regional societies.

J. Whitefield Gibbons—Whit Gibbons received his B.S. and M.S. at the University of Alabama and his Ph.D. from Michigan State University. He is a Senior Research Ecologist at the University of Georgia's Savannah River Ecology Laboratory and is currently Head of the Division of Stress and Wildlife Ecology. His previous research interests have focused on population ecology of vertebrates with particular emphasis on freshwater turtles. He has served as Chairman of the ASB Awards Committee, ASB Conservation committee, Vice President of the Southeastern Chapter of ESA, and President of the Southeastern Chapter of ASIH.

George G. Murphy—Zoologist, Professor and Chair of the Department of Biology, Middle Tennessee State University, Murfreesboro, Tennessee. Dr. Murphy received the B.S. degree in Biology from Austin Peay State College (1965) and the M.S. (1967) and Ph.D. (1970) degrees in Zoology from Mississippi State University. He has been at MTSU since 1969, where his chief teaching duties have been undergraduate and graduate vertebrate zoology courses. Dr. Murphy's research interests are in reproductive cycles and ecology of amphibians and reptiles, and he has directed the research of 15 masters degree students. He is a member of the Herpetologists League, Society for the Study of Amphibians and Reptiles, Sigma Xi, Phi Kappa Phi, and the Tennessee Academy of Science. He has been a member of ASB since 1969 and has given papers at meetings, served as paper session chairman, served on the Meritorious Teaching Award Committee (Chairman, 1978) and was Chairman of the Local Arrangements Committee for the 1985 meeting.

Diane R. Nelson—Professor of Biological Sciences, East Tennessee State University, Johnson City, Tennessee. Dr. Nelson earned her B.S. in Secondary Education (natural science), M.S. and Ph.D. in Zoology from the University of Tennessee–Knoxville, where she received an NSF Research Assistantship and a NASA Traineeship. Her research interests are in the systematics and ecology of the Tardigrada (water bears), utilizing scanning and transmission electron microscopy for morphological studies. She teaches courses in general biology (for non-science majors), invertebrate zoology, and marine biology. Active as a member of ASB for approximately 20 years as a student and a teacher, she has presented numerous papers at the annual meetings and has served as Section Chairperson, Tennessee State Correspondent, Conservation Committee member, and Research Awards Committee (member and Chairperson). In addition to holding membership in many professional societies, she has also been Secretary of the Tennessee Academy of Science for several years and has served the Academy as a member of the Executive Committee, Visiting Scientist Program, and as Section Chairperson and Fellow. Since 1982, she has been studying marine biology for several weeks each summer at the Bermuda Biological Station, and she is a "Voluntary Ambassador" in their Outreach Network.

ANNOUNCEMENTS

Extra copies of **ASB Bulletin**, volume 33, number 4, which featured nine articles on a symposium entitled "Biota, ecology, and ecological history of Cedar Glades," are available for $2.50 each: Tennessee Department of Conservation, Cultural Resources Sales Center, 701 Broadway, Customs House, Nashville, TN 37219-5237 (Phone 615/742-6706).

All members are encouraged to submit papers for consideration and publication in the ASB Bulletin. At present, no back log or delays exist. (Editor).

MOUNTAIN LAKE BIOLOGICAL STATION SUMMER FIELD COURSES 1987

First Term (14 June–18 July)

Ornithology
Kerry and **Patricia Rabenold**
Purdue University

Plant-Animal Interactions
Steven N. Handel
Rutgers University
Earl D. McCoy
University of South Florida

Plant Taxonomy
Spencer Tomb
Kansas State University

Workshop in Allozyme Techniques
Charles R. Werth
University of Kansas

Second term (19 July–22 August)

Community Ecology
Normal L. Christensen
Duke University
Henry Wilbur
Duke University

Mammalogy
Gordon L. Kirkland, Jr.
Shippensburg University

Plant Population Biology
Keith Garbutt
Harvard University

Scholarships Available: Service Awards for students covering room and board costs
Scholarships which provide financial assistance
Post-Doctoral Research Awards (10 weeks)

For further information and application, write to:

Dr. Blaine J. Cole, Director
Mountain Lake Biological Station
Rm. B-64 Gilmer Hall
University of Virginia
Charlottesville, VA 22901

REVIEWS

Kershaw, Kenneth. **Physiological Ecology of Lichens.** Cambridge University Press, Cambridge, MA. $59.50. 293 p.

As Kershaw remarks in his preface, lichenology was a fairly obscure branch of biology until their use as bioindicators in air pollution was finally appreciated. Compared to other fields of botany, there is a real lack of general texts that nonlichenologists can refer to, as well as specialized texts covering particular aspects. Kershaw's book is by any standard the most comprehensive effort to date to present a coherent picture of our knowledge of physiological ecology, a subject barely covered in most texts.

Kershaw began his studies of lichen physiology in the early 1970's and over a decade authored alone and with his students nearly 50 papers. Emphasis has been on field and laboratory measurements on all aspects of whole-thallus physiology. However, this information was scattered over many journals and quite fragmented. **Physiological Ecology of Lichens** now pulls together all of his experimental data with references to other pertinent works both in lichenology and in higher plants. The result is a well-written, highly informative and balanced summary of this very interesting field of lichenology.

The text is divided into nine chapters dealing with temperature, moisture, mineral uptake (including air pollution, especially mechanisms of elemental accumulation), nitrogen fixation, photosynthesis, respiration, and phenotypic plasticity. There are numerous charts and graphs, many taken from his own works.

This long-awaited book will be of interest to lichenologists, mycologists, microbiologists, and ecologists in ecosystem research.

Mason Hale, *Division of Cryptograms, Smithsonian Institution, Washington, DC* 20560.

Tiffney, Bruce H. ed. 1985. **Geological Factors and the Evolution of Plants.** Yale University Press, New Haven, CT. $25.00. 294 p.

This book is the proceedings of a meeting at Montreal in August, 1982 concerning the "Synergistic Interaction of Organism and Environment as Viewed on the Paleontological Time Scale." The meeting was co-chaired by Patricia Gensel and Andrew Knoll.

The book presents 15 papers organized under the following topics: Geological Factors and the Evolution of Plants, Adaptive Aspects of the Origin of Autotropic Eucaryotes, Geological Factors and Biochemical Aspects of the Origin of Land Plants, Early Development of Continental Ecosystems, Early Devonian Continental Positions and Climate: A Framework of Paleophytogeography, Early Devonian Phytogeography, Phytogeography and Paleoclimate of the Early Carboniferous, The Influence of Climate and Depositional Environment on the Distribution and Evolution of Pennsylvanian Coal-Swamp Plants, and Wildfire: An Interaction of Biological and Physical Processes.

The chapters are well written and illustrated when appropriate. The level of writing and complexity of the various papers is uniform, a tribute to the writers, editor, and reviewers. It is a very readable book even for individuals not highly versed in paleobotany. Each chapter has an extensive set of references which greatly enhances the value of the book.

The relatively wide scope of the book plus the well written and well edited chapters make an excellent addition to the library of those even slightly interested in paleobotany or paleoclimatology.

Roy B. Clarkson, *Biology Department, West Virginia University, Morgantown, WV* 26505.

News of Biology in the Southeast

JON R. FORTMAN—*News Editor*
Division of Science and Mathematics
Mississippi University for Women
Columbus, Mississippi 39701

ABOUT PEOPLE AND PLACES

Alabama

University of North Alabama, Department of Biology. *Dr. Thomas H. Haggerty* (Ph.D., University of Arkansas), with research interests in ornithology, ecology, and animal behavior, joined the department in August 1986. He worked with the National Park Service prior to entering graduate school and has considerable teaching experience at the college level.

The University of Alabama, Department of Biology. *Dr. Perry Churchill* (Ph.D., Wayne State University) joined the faculty as an Assistant Professor following a post-doc at Vanderbilt University. His research interests are in molecular biology and biochemistry. *Dr. Keller Suberkropp* (Ph.D., Michigan State University), also new to the department, was an Associate Professor at New Mexico State University prior to acdepting his new position as Associate Professor. Dr. Suberkropp's research interests are in aquatic microbial ecology.

Tuskegee University, Department of Biology. *Dr. James H. M. Henderson* and *Dr. Walter Hill* spent six months at the International Institute for Tropical Agriculture in Ibadan, Nigeria conducting research on the sweet potato. One aspect of *Dr. Henderson's* research involved the techniques of producing virus-free sweet potato clones. A grant from NIH/DRR was awarded to Tuskegee University for the 15th year for the Minority Biomedical Research Support Program. The amount covering the period of June 1986 to May 1987 is $463,540. The program involves about 20 faculty and about two dozen students, two-thirds of whom are undergraduates. The research is biomedical in scope and involves electron microscopy, molecular and microbial physiology, molecular cytogenetics, blood chemistry, and physiology. The program director is *Dr. J. H. M. Henderson.*

Florida

Rollins College, Biology Department. *Donald Mansfield,* Assistant Professor of Biology, has published the results of his research on rice and watergrass in a paper entitled, "Effects of Ethephon and its Decomposition Products on Germination of Rice and Watergrass" in *Crop Science,* Volume 26, 1986.

Georgia

Savannah State College, Department of Biology and Life Sciences. The department has received continuation of four externally funded research and educational programs for the 1986–87 academic year. The Minority Biomedical Research Support Program, directed by *Dr. C. Obi Emeh,* provides $500,000 to support eight faculty, 25 students, and 4 technical research assistants. The Minority Access to Research Careers Program, directed by *Dr. H. Singh,* has a budget in excess of $100,000 to support four students. The National Oceanic and Atmospheric Administration Marine Research Program, directed by *Dr. M. Gilligan,* provides opportunities for undergraduate research experience and training in cooperative projects with the Southeast Fisheries Center of the National Marine Fisheries Service. Finally, the General Telephone and Electronics Foundation Lectureship Series provides funds for a number of distinguished speakers to come to the College and give talks within the area of "Current Issues in Biomedical and Environmental Sciences." *Dr. Thomas Kozel* is the coordinator of the Environmental Studies Program. Funding has recently been approved for the construction of a wet-laboratory/dock/teaching facility at the College to enhance the state's only BS degree program in Marine Biology.

Fernbank Science Center, Public Relations, Atlanta. *Dr. Patricianne Hurd,* an electron microscopy instructor, presented the paper "Surface Topography Variation of the Scolex of the Cysticercus of *Hydatigera taeniaeformis*" at the 11th International Congress on Electron Microscopy in Kyoto, Japan. The SEM poster session was co-authored by *Dr. Betty Jones,* Morehouse College.

Georgia Southern College, Department of Biology. Fall 1986 seminars sponsored by the Department of Biology and The Campus Life Enrichment Committee were: "How Ants Conquered the World," by *Dr. E. O. Wilson,* Baird Professor of Science, Harvard University; "Disease Relationships of Phlebotomine Sand Flies in the New World," by *Dr. David G. Young,* Department of Nematology and Entomology, University of Florida; "Ecology of the Loggerhead Sea Turtle *Caretta caretta* in Georgia," by *Dr. Nat B. Frazer,* Department of Biology, Mercer University. Other distinguished speakers were *Dr. Gordhan Patel,* Department of Zoology, University of Georgia who lectured on "Functional Analysis of a DNA Helix Unwinding Protein," and *Dr. John R. Bozeman,* Assistant Chief, Marsh and Beach Section, Georgia Department of Natural Resources, who spoke on "Serendipity vs. Finesse in the Search for the Georgia Plume (*Elliottia racemosa* Muhl.)." *Dr. Allan Fone,* Department of Botany, The University of Georgia, gave a seminar in November 1986 on "Reproductive Ecology of Annual and Perennial Cat's Ears (Compositae)." Closing out the Fall seminar series was *Dr. Greg Kormanik,* Department of Biology, University of North Carolina, who talked on "Acid Base Balance and Nitrogenous Waste Excretion in Developing Shark Pups."

The University of Georgia, Botany Department. *Dr. Samuel B. Jones* and *Mrs. Nancy C. Coile* announce that a compactor system has been installed in the UGA Herbarium at a cost of $174,000, almost doubling the storage capacity for the collection. The National Science Foundation provided $114,000 and the remainder of the funds were from UGA. An open house will be held at the Herbarium during the April ASB meeting in Athens.

Illinois

Southern Illinois University, Botany-Forestry Department. *George T. Weaver,* former Chairman of the Department, has been appointed Professor and Head of the Department of Forestry, Wildlife, and Fisheries at The University of Tennessee, Knoxville. A course entitled "Field Ecology Studies in the Northern Rocky Mountains" will be taught during the summer 1987 for 6½ weeks. The base of operation for the course will be the YBRA Field Camp located at the foot of the Beartooth Mountain near Red Lodge, Montana. Students will study ecological characteristics of shrub-desert grassland, coniferous forest, and alpine tundra ecosystems. The course should appeal to students majoring in Botany, Zoology, Biology, Forestry, Conservation, and Wildlife Biology. It is designed to develop field capabilities by teaching plant identification, field ecology methods, and landscape interpretation. Total cost will be about $160 per week which includes travel to and from Carbondale, Illinois, tuition, books, fees, room and board, and travel expenses. Out-of-state students pay the same tuition as Illinois residents. For exact dates and more information contact *Dr. P. A. Robertson,* Department of Botany, Southern Illinois Univ., Carbondale, IL 62901, (618/536-2331) by 15 March 1987.

Louisiana

Louisiana State University, Department of Botany. *Dr. Thomas S. Moore* has been invited to give an oral presentation on plant lipids at the XIV International Botany Congress in West Berlin. *Dr. Russell L. Chapman* has been invited to speak on "The Trentepohliaceae and Current Concepts of Green Algal Classes, and the Origin of Land Plants," at the XIV International Botanical Congress in West Berlin. *Dr. G. Bruce Williamson* received support for the projects entitled: "Extreme Radial Changes in Specific Gravity of Tropical Woods" and "Effects of Fire on Vegetation in Upland Longleaf Communities in Southeastern Louisiana." *Dr. James B. Grace* spent two months last Spring with the CSIRO in Darwin, Australia as a Visiting Research Scientist. He received a 3-year grant from NSF for work on marsh plants and has been elected vice-chair of the Ecological Section of the Botanical Society of America. He chaired a paper session on plant competition at the recent International Ecology Congress in Syracuse, NY.

North Carolina

Western Carolina University, Department of Biology. The department was the first to receive the newly established WCU Academic Award for the "Program of Excellence." The award included a $10,000 stipend which the Biology faculty used to initiate an endowed scholarship fund for supporting

Biology students. *J. W. Wallace* was elected as Chairperson of the Phytochemical Section of the Botanical Society of America and as a co-editor of the "Phytochemical Bulletin."

Elon College, Department of Biology and Allied Health. *Dr. W. David Sissom* from Texas Tech University has joined the faculty as Assistant Professor of Biology, filling the vacancy left by the retirement of *Mr. V. F. Morgan. Dr. Sissom* specializes in the systematics of scorpions.

Wake Forest University, Department of Biology. *Dr. Robert A. Browne,* Associate Professor of Biology, has received grants from the National Geographic Society, the Whitehall Foundation, and a Fullbright Research Scholarship to study the population biology of brine shrimp. These studies will take place over the next three years at Wake Forest and the University of Ghent in Belgium. *Dr. Carol Browne,* Associate Professor, has been awarded a two-year NIH Academic Research Enhancement Award to study the role of cAMP in the regulation of mitotic spindle microtubules. The Second Perspectives in Biology Symposium was held at the University on 26 and 27 September. Speakers were *Dr. Mary-Dell Chilton,* a plant molecular biologist with CIBA-GEIGY, *Dr. Niles Eldredge* of the American Museum of Natural History, and *Dr. George Hill,* Director of the Division of Biomedical Sciences at Meharry Medical College. *Dr. Ronald Dimock,* Chairman of the Department, was one of a group of six faculty from colleges and universities in the Eastern U.S. that were invited to the Bermuda Biological Station for Research. The group was asked to evaluate scientific and promotional literature from the Station as part of an effort to attract more faculty and student groups to use the facility for teaching and research.

South Carolina

University of South Carolina, Department of Biology. *Roger H. Sawyer* (Ph.D., University of Massachusetts) has been appointed Chairman of the Department. *Dr. Sawyer* is internationally known for his research in the field of developmental biology, especially in the area of epithelial mesenchymal interactions in gene expression.

Tennessee

Tennessee Tech University, Upper Cumberland Biological Station (Tech Aqua). The following summer courses are announced for 1987. May term, 18–29 May: Behavior of Aquatic Organisms, Instructor, *Butler* (Penn. State). First regular term, 7 June–9 July: Freshwater Invertebrates (*Prins,* WKU), Herpetology (*Murphy,* MTSU), Local Flora (*Hunter,* TTU), Ichthyology (*Doucette,* SLU), and Field Investigations. The second regular term, 11 July–14 August: Entomology (*McGhee,* MTSU), Ecosystems Analysis (*Winstead,* WKU), Savage Gulf Research (*Martin,* EKU), and Field Investigations. The July term, 11–24 July: Malacology (*Stansberry,* Ohio State). For further information contact: *Dr. C. B. Coburn,* Upper Cumberland Biological Field Station at Tech Aqua, Tennessee Technological University, Cookeville, TN 38505-0001, (615/372-3194).

Virginia

University of Virginia, Department of Biology. *Dr. Michael Menaker* will leave his position as Director of the Institute of Neurosciences at the University of Oregon to assume the chairmanship of the Department of Biology in January 1987. *Michael P. Timko,* a specialist in plant molecular biology, joined the faculty as Assistant Professor.

James Madison University, Department of Biology. The University is developing 25 acres of its woodland into an on-campus arboretum. The complex will provide an outdoor facility serving the purposes of education, research, and demonstration for students at all levels, professional botanists, horticulturists, gardeners, and the general public. The property on which the arboretum is being developed is an easily accessible woodland east of I-81 on the east side of the campus. A mature Oak-Hickory forest association covers the gentle slopes of the site.

ABOUT MUSEUMS AND BOTANICAL GARDENS

Alabama

Anniston Museum of Natural History. Exhibits for January through June, 1987 are: "Forest of Feelings," 22 January–28 February, a collection of colorful wildlife murals by artist Greg Bruce of

Athens, Georgia. "Audubon's Animals," 13 March–10 April, an exhibition of 54 hand colored lithographs of the birds and animals of John James Audubon. "Wildlife in Bronze," by Tom Tischler, 1 May–28 June, an exhibition of lost wax bronze castings of many wildlife species.

Kentucky

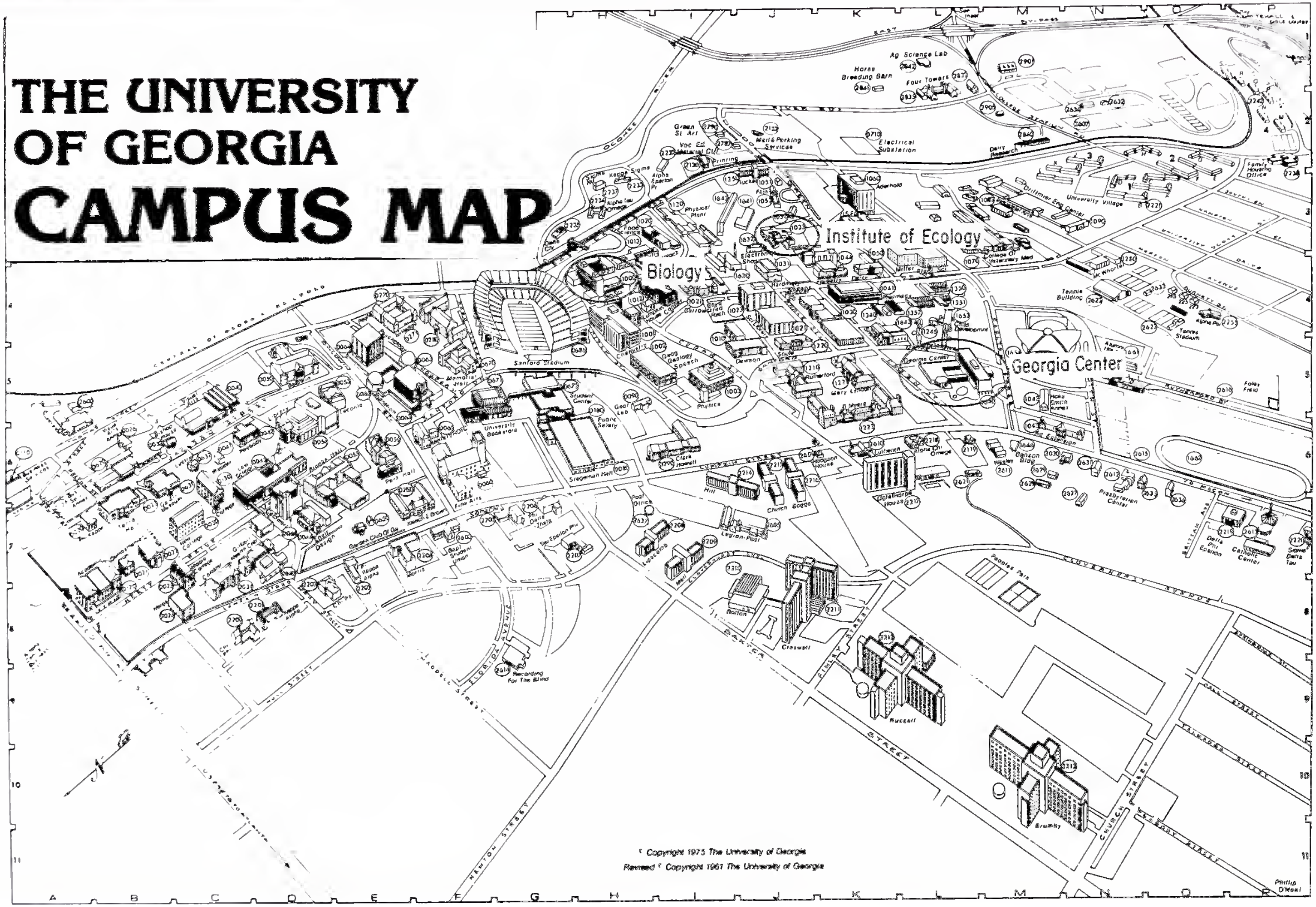
Museum of History and Science, Louisville. The Museum was the first national host to the touring exhibit "Raceways!" on display the Fall of 1986. A solar collector, built miles away and years ago, is the newest addition to the Museum collection. The artifact was created in Australia, and exhibited at the World's Fair in Knoxville, TN. After the exhibition, the collector was stored at the Atomic Energy Museum. It weighs over 2,000 pounds, and is covered with mirrored tiles. It focuses sunlight to the collector's center, and can register temperatures up to 1,800 F, generating steam power. *Dr. William Sudduth,* the Museum president, arranged to have it moved to Louisville for display. Five new staff members have been added to the Museum staff. They are: *Mr. Arnie Brouillard,* Development Manager, formerly of the Bellarmine College staff, who had five years experience in this area as well as teaching; *Ms. Andrea Fisher,* Marketing Secretary, a Museum member since 1985; *Ms. Denise Furnish,* Graphics Intern, an art major at the University of Louisville, as is *Mr. George Owens,* Graphics Assistant; and *Ms. Susanne Wright,* Special Events Coordinator, who has an extensive background in special events and marketing in the Louisville area.

The Museum and the Kentucky Art and Craft Foundation Gallery held a Family Open House for their members and patrons in December 1986. The Open House featured the Museum's annual holiday exhibit, "Toys, Trains, and Dolls," and the Gallery's exhibit, "Toys, Games, and Fantasies." The Museum will officially open "5th and York," a new permanent exhibit about the history of the Museum.

North Carolina

North Carolina Botanical Garden, University of North Carolina, Chapel Hill. *Dr. Peter S. White* is the new director of the Botanical Garden. *Dr. White* received his Ph.D. in plant ecology from Dartmouth and completed post-doctoral studies at the Missouri Botanical Garden. His most recent position was as leader of the Cooperative Park Studies Unit at the Great Smoky Mountains National Park and adjunct professor in the Graduate Program in Ecology at the University of Tennessee, Knoxville. *Dr. White* plans to expand the role of the Garden in research and continue the institution's commitment to plant conservation and public service. *Dr. C. Ritchie Bell,* director from 1961 to 1986, will continue his research on *Sanguinaria, Macleaya,* and umbellifer reproductive biology at the Garden's Mason Farm Biological Reserve and the UNC Department of Biology.

THE UNIVERSITY OF GEORGIA CAMPUS MAP



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The ASB BULLETIN

Volume 34, Number 2 (Supplement) April 1987

A Historical Perspective 1937–1987
50th Anniversary

48th Annual Meeting

The Official Quarterly Publication of
The Association of Southeastern Biologists

A 50-Year Historical Perspective 1937–87 of the Association of Southeastern Biologists

Walter S. Flory

Walter S. Flory
ASB President 1962–1963

A 50-YEAR HISTORICAL PERSPECTIVE 1937–87 OF THE ASSOCIATION OF SOUTHEASTERN BIOLOGISTS

Walter S. Flory

ASB President 1962–63
Professor Emeritus of Botany
Wake Forest University
Winston-Salem, NC 27109

This brief semicentennial history of the Association of Southeastern Biologists deals with the people, and the progress of these biologists, as they successfully developed an organization which has united the workers of some 10, or more, southeastern states into one of the strongest and most compatible of such groups in our time. The 50-year history of this organization has witnessed the progress and strengthening of the biological sciences, in the increasingly strong universities and colleges of our southeastern states.

A history is most often a story of the people, and their accomplishments, in a given enterprise. Both for conciseness and clarity the actions of the organization have been essentially summarized in the tables presented here. In the text each table will be discussed and handled as briefly as possible.

Why was an organization of the southeastern biologists desirable, and what accounted for its origin? This question can be answered most easily by referring to a description of the beginning of the organization by George H. Boyd (1957, ASB Bull. 1: 3–7) at the time of the twentieth anniversary of the Association. To preface the description it is helpful to know that in 1937 Dr. Boyd was Professor of Zoology, and also the recently appointed Chairman of the Division of Biological Sciences, at the University of Georgia. The following section is mostly composed of excerpts from the 1957 article by Dr. Boyd, referred to above.

Origin: "In this day of numerous meetings and abundance of travel I am sure professional isolation is a term that has lost much of its former significance. And yet, as recently as a quarter of a century ago many of us who were engaged in scientific teaching and research in the South were keenly impressed with the need for easier and more frequent contacts with our colleagues in the region. Some of us attended national meetings more or less regularly, but we were largely lost from each other in the crowd. In a limited way we commonly kept our contacts with the institutions in which we had pursued graduate work, and through these contacts, we were, on the whole, better acquainted with the work of scientists in other parts of the country than with our fellow scientists in the South. Many of us felt that the scientific advancement of the South would be greatly enhanced by better acquaintance and easier communication between scientists with a common interest in the region. As a consequence of this conviction, the period of 1930–40 was one in which considerable interest in regional organizations and regional problems was manifest.

"The ASB had its beginning in an invitational meeting held at the University of Georgia on 7 and 8 May 1937, the invitation to attend and participate being extended by the members of the staff of the Division of Biological Sciences of this institution (Georgia) to biologists in Georgia and in those states immediately surrounding Georgia (Alabama, Florida, South Carolina, North Carolina and Tennessee)."

"For some of us, at least, the 1937 meeting proved to be a very enjoyable affair. It was attended by fifty-eight persons, and the sessions were devoted mostly to the reading and discussion of research papers."

"This meeting was not called specifically for the purpose of organizing an association of biologists, though it was hoped by some of us that an interest in such an outcome would result. Such an interest immediately became apparent, and the group voted to organize the Association of Southeastern Biologists." "Officers and an Executive Committee were elected. Plans were made for: developing a proposed constitution and by-laws; the issuance of invitations to membership; and planning for a 1938 meeting." "It was decided that the group would return to the University of Georgia for its first formal meeting."

"The membership of the Association has shown phenomenal growth." "In more recent years members have been drawn from an area extending all the way from Maryland to Texas." "This geographical expansion has permitted an increase in membership that would have otherwise been impossible. At any rate, our current membership of 609 represents a remarkable growth."

From time-to-time the Charter Members of the Association are mentioned, in one sense or another. In connection with this history an effort has been made to discover and contact any such members. Two former Treasurers of the organization (Drs. Flagg and O'Kelley) have been consulted, and existing records of the Treasurer's office reveal only one surviving member. That person is Professor Wilbur H. Duncan (Fig. 1) retired botanist of the University of Georgia. An occasional reference to some person as a Charter Member is seen, but a careful search, in such cases, has always failed to reveal substantive supporting evidence of the fact. If other Charter Members, than Dr. Duncan, are still members, they should make themselves known—and announcement, and record, made of this.

After this author joined the Association in 1949, during the 1950's and later, much pleasure was derived from the time-to-time reminiscing conversations with, and between, some of the earliest leaders of the group: persons such as Elon Byrd, Herman Kurz, Orland White, F.A. Wolf, etc.—men all now deceased. When the origin of the Association would be discussed, George Hugh Boyd (Fig. 2), the organization's first President, was almost always cited as the person having the original idea for such an organization—the man giving the most impetus to its founding and early progress!

Meetings: Dr. Boyd's 1957 article discusses the early meetings. As mentioned 58 persons attended the 1937 meeting in Athens. At the 1938 meeting in Athens 76 were in attendance. Over 100 persons were present at the fourth, 1940, meeting in Nashville. "Thereafter the number gradually, but steadily increased, until at the 1947 (1949?) meeting at the University of Tennessee the attendance was recorded as 331. This meeting represents the high point in attendance during the first twenty years . . . Since that meeting the number has ranged from 190 to 231."

With the exception of the war years there have been annual meetings of the ASB since 1937. In 1943, 1944 and 1945 many members were scattered throughout the world taking part in the prosecution of World War II. Also during that time travel was difficult. Gas, tires, and even cars were scarce. The Office for Defense Transportation placed drastic limitations upon travel for non-military purposes. That the Association survived through the war years was due to the

Fig. 1. *Professor Wilbur H. Duncan,* Professor of Botany, Emeritus, of the University of Georgia is apparently the lone surviving Charter Member of the ASB. Professor Duncan joined the Georgia staff in 1938, after earning his Ph.D. at Duke University in that same year. At Georgia he has been responsible for developing one of the finer herbaria in the Southeast. He is well known by his books and works on the southeastern flora.

gallant efforts of the President, Dr. Mary S. MacDougall, and the Secretary-Treasurer, Dr. Martin D. Young, in keeping the membership informed and interested. As a result of their work the Association smoothly resumed its usual activities in 1946.

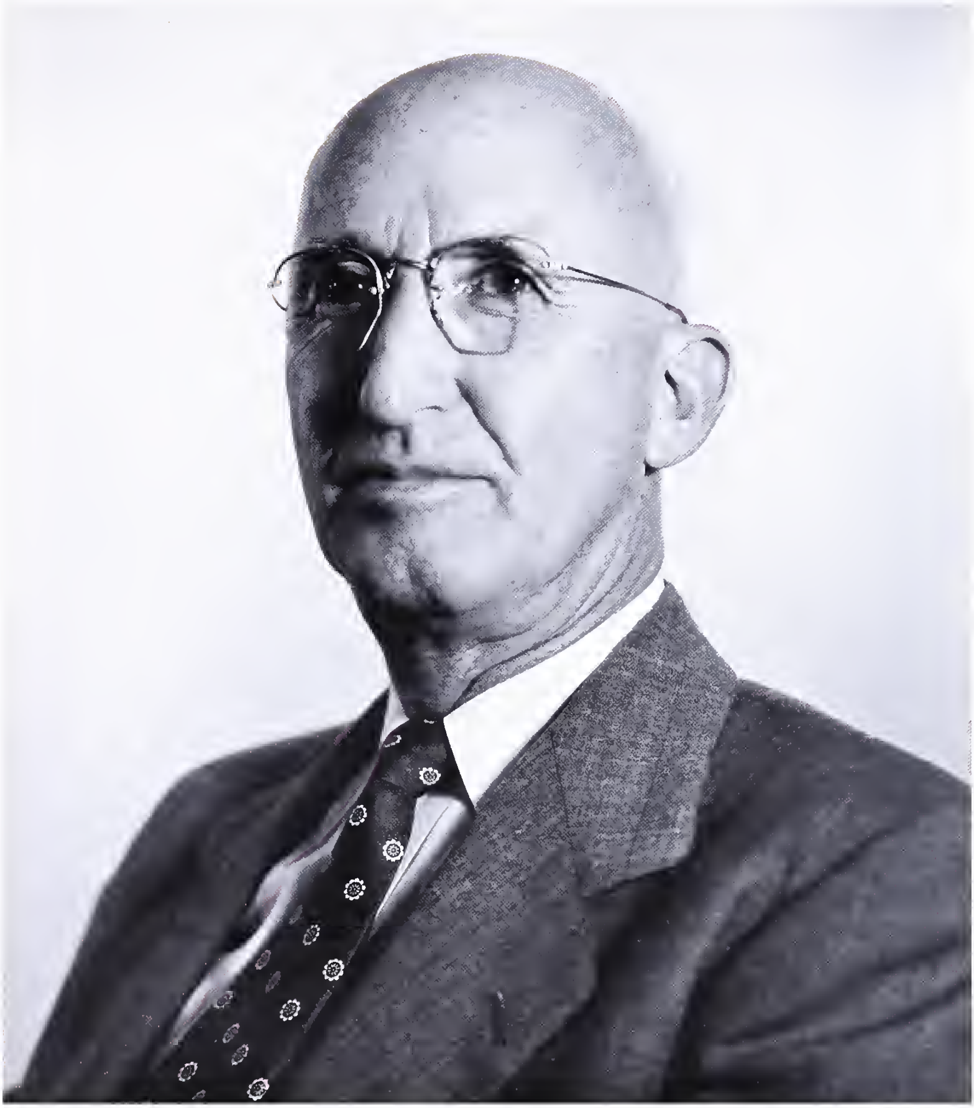

Fig. 2. *George Hugh Boyd* (1891–65) founding President of the Association of Southeastern Biologists. Late Professor of Zoology, Chairman of the Division of Biological Sciences, and Dean of the Graduate School, of the University of Georgia.

Cities where the ASB has met, along with the names of the host institutions, are listed in chronological order in Table 1. The list starts with the organizational meeting in Athens in 1937, running through the 1987 Fifty Year Anniversary Meeting which, quite appropriately, is—for the fifth time—at the University of Georgia.

A picture of the range and diversity of meeting places is provided by Table 2. The Association has held its annual meetings in nine different states, ranging from Virginia to Louisiana, and from Florida to Kentucky. It has met with 33 different host institutions, in 31 different cities. Institutions in Georgia have hosted nine meetings; those in Tennessee six meetings; and those in North Carolina six meetings. Perhaps this concentration is to be expected for these states are as centrally located as any, in this rather asymmetrically shaped region. However, Florida institutions have also hosted six annual meetings. And this, also, cannot be considered unexpected. While Florida is certainly a perimeter state of the region, its fine schools are coupled with a usually fine climate and many other 'tourist' attractions.

Planning, arranging, and executing the plans for an Annual Meeting for an organization the size of the ASB is not a simple task. The several hundred members attending are often accompanied by wives, and others. This calls for the provision of a significant number of bedrooms within easy reach of the program area. The members' diverse interests necessitates having a half-dozen, or more, simultaneous program sessions, plus sometimes additional symposia and forums. Plans have to be made for presiding chairpersons, projection equipment, and often other items, for each of these sessions. The program rooms preferably should be near one another, making for easy transit from one program to another. Also, arrangements for feeding such a group presents some complexities. Suitable nearby restaurants must be found, and information given to the membership. In addition to planning for the big ASB banquet—with its awards presentations, Past-President's address, announcement of new officers, etc.—arrangements have to be made for the breakfasts, luncheons, and banquets of the various special groups and organizations.

As the membership of the Association has grown, with its consequent increase of attendants at the annual meeting, it has made it necessary to make decisions on places of meeting several years in advance. A Local Arrangements Committee, often composed of 8 to 12 persons—each with certain responsibilities—works with officers of the organization for many months in advance of the meeting. This planning has resulted in well arranged, smoothly running programs and functions which almost always have won the praise of all attendants. In several cases slightly known, especially younger, biologists have caught the attention and admiration of the Associations membership because their outstanding service on a Local Arrangements Committee. This has led to later leadership roles in the ASB.

Officers: In the fifty year history of the ASB the officers and elected Executive Committee Members have included representatives of some 60 different institutions. These representatives have come from 12 different states and the District of Columbia. They include persons from institutions in states as far north as Maryland and West Virginia. As would be anticipated, a greater number of these officers have come from the larger institutions in the more centrally located states of the region. However, it is somewhat amazing to note the proportion of people who have come from some of the smaller colleges of the region. This is true all the way through from Virginia to Mississippi and Louisiana. This would indicate that the objective of the Association for the betterment of biological teaching and research in the South is being felt all along the collegiate trail—from the smallest college to the largest university. There has been a President from a small Maryland college, and one from the District of Columbia; a Vice-President from the District of Columbia; one of the annually named Most Meritorious Teachers is from the District of Columbia, one from the University of West Virginia, and another from a small Virginia college, and so on.

Table 3 lists the Presidents and Vice-Presidents of the first 50 years of ASB history. Table 4 registers the people who held the joint Secretary-Treasurer position from 1937 until 1951. Also, the persons who served in the separate capacity of either Secretary, or Treasurer, from 1951 to date. Table 5 enumerates the elected representatives to the Executive Committee over the last 50 years.

It can be noted that in a number of cases persons have advanced from the Executive Committee to the posts of Vice-President or President; or from Secretary, or Treasurer, to higher position. However, in a surprising number of cases persons holding no former official position, when placed on the ballot by the Nominating Committee to run for—say President—against an incumbent officer, have won out over the 'incumbent.' This speaks heavily for the democracy of the organization.

One point concerning Table 3 may need to be made clear. For 1951–52 H. P. Sturdivant is listed as Vice-President. Also, this same gentlemen is listed, along with W. A. A. Deacon, as President—for that same year. The explanation: shortly after the election Dr. Deacon, because of illness, was forced to give up the Presidency. Dr. Sturdivant, shortly after his year as Vice-President started, found it necessary to take over the work of the President. Because of Dr. Sturdivant's able and faithful service all through the year, the Association elected him President for the 1952 meeting at Agnes Scott College.

The ASB Bulletin: Even in the very earliest days of the Association there was discussion by officers and members about the advantages of some medium of communication—other than letter or phone—to go to all members on a regular basis. An organ which would serve to inform, unify, and help in developing the interest and loyalty of the membership!

World War II, whose menacing presence began to be felt soon after 1937 was a disturbing influence on many things, especially those of a non-military nature. Any hopes of quick action, on any sort of publishing project, dimmed in the confusion caused by the war and its aftermath.

In 1940 the *Journal of the Tennessee Academy of Science,* aware of the still unresolved publication problem of the ASB, generously offered to publish the *Proceedings* of the annual meetings of the ASB. Its offer was accepted. The *ASB* annual meeting *Proceedings* were then published in the Tennessee journal until 1954 (with the exception of 1943–45, when no annual meetings were held). And, of course, after 1954 the *Proceedings* were published in the ASB's own journal, as described in the following account.

In the early fifties, while visible progress was lacking, ideas regarding a publication for the ASB had been fomenting in more than one mind. But, chiefly, in the minds and plans of a University of North Carolina botanist, Victor A. Greulach, and the officers of the Association with whom he had consulted. Greulach was a native of Ohio, with a Ph.D. in Botany (Physiology) from Ohio State University. He had held several teaching positions, chiefly in Texas (Univ. Houston; Texas A&M), before transferring to the University of North Carolina–Chapel Hill in 1949. Dr. Greulach edited the first five volumes of *The ASB Bulletin,* getting the new journal off to a splendid start. The first issue (Vol. 1, No. 1) appeared in March 1954. On the Editorial page of this first issue under "*The ASB Bulletin,*" and also under "Victor A. Greulach, Editor" it stated: "*The ASB Bulletin* is the official quarterly publication of the Association of Southeastern Biologists and is published at Chapel Hill, NC in March, June, September, and December." Further down the page the "Officers of the ASB" were listed. Also, on this page were congratulatory letters from: Bruce D. Reynolds, University of

Virginia, President, ASB; Frank A. Campbell, Editor, *AIBS Bulletin*; Earl L. Core, Editor, *Castanea*; John N. Couch, Editor, *Journal of Elisha Mitchell Scientific Society*; and Duane Roller, Editor, *Science.* Following the usual Editorial Page—on the opposite page—was a special editorial, signed V.A.G.: "*About the ASB Bulletin.*" This editorial outlined the intended purpose, and the expected content of the new *Bulletin,* as well as the apparent relationship anticipated between it and other scientific journals having to do with Southeastern science, and especially with Biology.

Dr. Bruce Reynold's (President ASB, 1953–54) letter, in this first *Bulletin* issue, was most interesting and contained some statements with which it is thought nearly all ASB members (then and now) would agree. Because of their pertinence certain parts of this letter are quoted here:

"It is a real pleasure to send you greetings in this the first issue of *The ASB Bulletin.* I consider the establishment of this publication as a major step in disseminating news and molding opinions concerning things biological. We are fortunate in having Dr. Victor A. Greulach as our editor, for already he has shown an interest and comprehension that argue well for the future.

"I want to tell you that I enjoy membership in the Association of Southeastern Biologists more than in any other organization. This is due to the fact that we are a congenial group having the same interests and speaking the same language. In our meetings there is a spirit of cordiality, cooperation and democracy beyond that exhibited in most groups. We now have about 550 members, nearly twice as many as we had five years ago. There are other biologists in our region who would be benefited by joining with us."

The ASB Bulletin is well serving its intended purpose. It gives the call for papers; the call for nominations for officers; and for Most Meritorious Teacher; the call for candidate papers for the Research Prizes. The *Bulletin* prints, in advance of the annual meeting: the programs; the abstracts of research papers; the report of the Nominating Committee, usually with pictures and short biographies of the various candidates; and after the meeting prints: reports and summaries of the meeting; summaries—and often full coverage—of the various symposia, and invited talks and lectures; information on nearly elected officers, and on the winners of the various awards; brings the membership continually more short research articles; prints "News of Biology in the Southeast" under such titles as 'About People'; 'About Places'; 'About Institutions'; 'About Museums and Botanical Gardens'; 'About Field Stations'; etc. This news is prepared under the direction of a News Editor aided by a corps of State Correspondents.

The several Editors, Business Managers, Circulation Managers, and their Assistants since *The ASB Bulletin* started publication in 1954, are listed in Table 6.

It can be seen, from Table 6, that Dr. Greulach, the initiating Editor, expanded his staff, with Volume 2, by adding an Associate Editor, a Business Manager, and a Circulation Manager. The new Associate Editor was the incumbent Secretary of the ASB. The new Business Manager was the incumbent Treasurer of the ASB. The combining of the offices of Secretary and Associate Editor of the *Bulletin,* and of the office of Treasurer with that of Business Manager of *The Bulletin* has continued, from the time of the 1956 annual meeting until the present—the beginning of 1987. There are obvious advantages to the interlocking situation resulting from the combining of special *Bulletin* duties, with those of the incumbents of certain offices in the Association.

As already mentioned, Dr. Greulach—*The Bulletin*'s founding Editor—edited its first five volumes. After setting up successful policies and routines of publication, he relinquished the post at the end of 1958. Dr. Jeffery assumed the editorship for Volumes 6 and 7. With Volume 8, C. W. (Bill) Hart, Jr. began a lengthy tenure of eleven and a half years. Among Dr. Hart's fine contributions to *The Bulletin* was the development, in cooperation with the very capable Ms. Dorothy Hubbard of The Academy of Natural Sciences of Philadelphia where Dr. Hart was located before going with the Smithsonian in Washington, of the present sound circulation system for *The Bulletin.* Dr. Margaret Menzel, who had previously served three years as Associate Editor, followed Dr. Hart as Editor for a 5-year tenure. Dr. Gary Dillard then was Editor for the three years from mid-1977 to mid-1980. Dr. James Hardin then edited *The Bulletin* through the time of the 1986 annual meeting. *The Bulletin's* present, and seventh, Editor is Dr. Frank J. Schwartz. Dr. Schwartz, while located at the Institute of Marine Science, Morehead City, N.C. is—like the first Editor, Dr. Greulach—a staff member and Professor of the University of North Carolina at Chapel Hill.

The Association has been fortunate in its able and talented Editors who, with their capable supporting casts, have produced for the membership a steadily more helpful and superior *Bulletin.*

AWARDS

Research prize: With the war over, there was a resumption of the annual meetings in 1946, this one held at the University of South Carolina. It was decided at this Columbia meeting that at the next annual meeting, in 1947, an award would be given for a paper cited by the Association as an outstanding contribution to the meeting. The Carolina Biological Supply Company, through the courtesy of its President, biologist Dr. T. E. Powell, Jr. (Fig. 3), offered to supply the prize in the form of a check for $100. It is not known if this prize was the incentive, but the 1947 annual meeting at the University of Florida had an increased number of attendants and an unusual number of high quality papers. This first Research Award was won by Dr. Clyde E. Keeler of the Georgia State College for Women.

Machinery had to be set in motion to make determinations on future research awards. Soon an Awards Committee was appointed. Its first members were given terms of three, two, and one years, respectively. The one-year appointee was Chairman, and rotated off the Committee at the end of the first year, when the two-year appointee became Chairman. At the same time another 3-year appointment was made, to take the place of the retired Chairman. After that there was one new three-year appointee each year, with each member serving as Chairman his third year on the Committee.

So that papers can be given serious consideration, the Research Committee solicits manuscripts several months in advance of the annual meeting of members who think their contributions deserving of serious consideration for the Research Prize. All papers received by a certain date are then sent, according to a previously made agreement to some eminent Biology group outside the southeastern region for 'judging.' The judgement of this group as to the 'most excellent' submitted paper is transmitted to the Associations Research, or Awards, Committee. This committee then announces the decision to the members at the next annual meeting, and also through the *Bulletin.*

The Carolina Biological Supply Company sponsored the Research Prize from

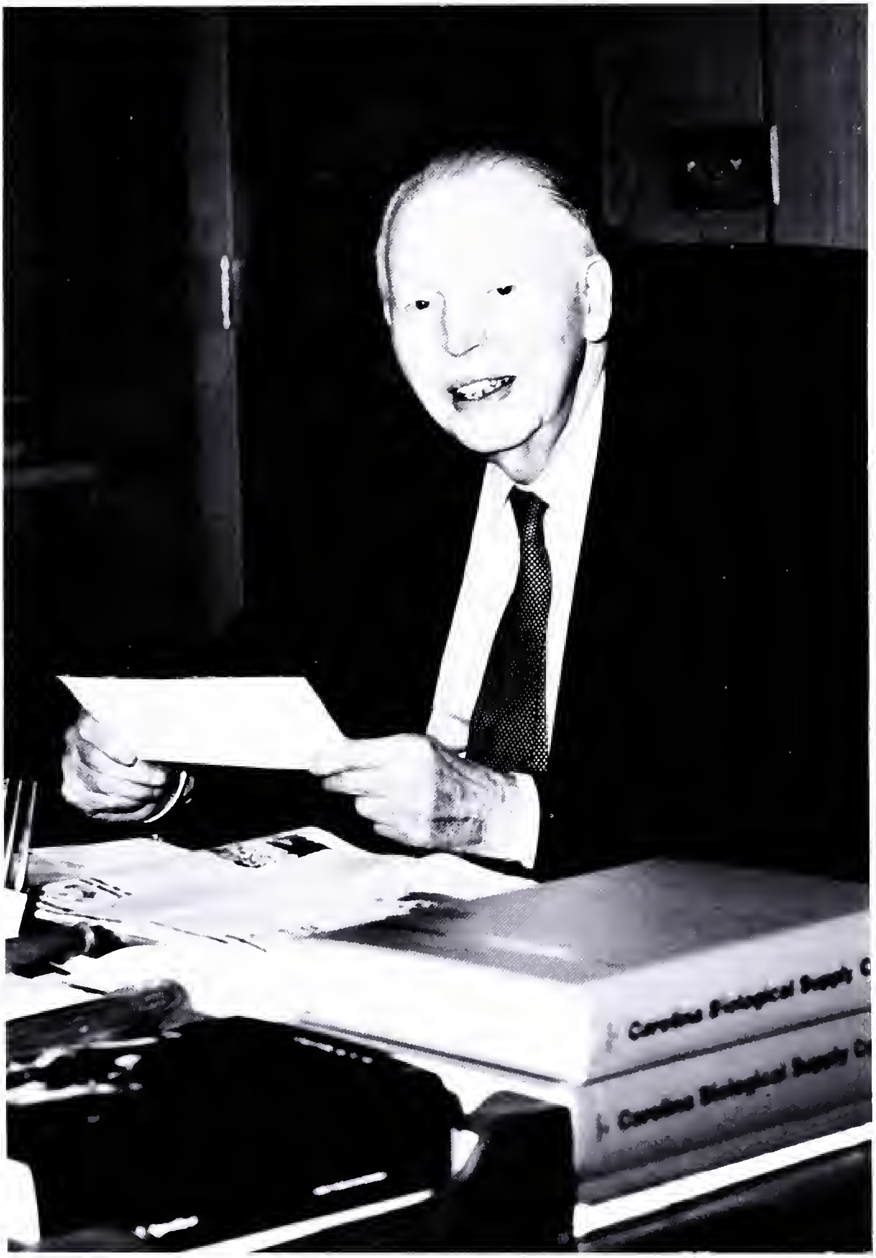

Fig. 3. *Dr. Thomas E. Powell, Jr.,* Founder and Chairman of the Carolina Biological Supply Co. Though not a charter member, Dr. Powell was involved in many of the early discussions about creating a southern association of biologists. His company has been one of the most active in support of the ASB: by having a company exhibit at each annual meeting; sponsoring the Research Prize from 1947 to 1949; sponsoring the Meritorious Teaching Award since 1980; lending the time of important personnel to serve as Treasurer and President of the ASB, and in other ways.

1947 through 1979. From 1947 through 1972 the prize was a $100.00 check. From 1973 through 1979, the award was a handsome, engraved, gold medallion. Starting in 1980 The Beckman Instruments, Inc., of Norcross, Georgia, took over sponsorship of the research award, the annual prize being $500.

Meritorious Teaching Award: The initiation of the annual Research Award started some serious thinking about the objectives of the Association. Clearly, one objective was the fostering of research, as indicated by the number of, and the quality of and interest in, the papers presented at the annual meetings.

But the thinking was that the Association should have further and broader objectives, and certainly some touching seriously on the teaching field. This thinking solidified into action at the final ASB Council meeting, at the annual meeting at the University of Virginia in April, 1950. Dr. Elon E. Byrd who just had been elected President of ASB for the year 1950–51, had previously secured a commitment from the Southern Scientific Company of Atlanta to sponsor an annual Meritorious Service Award, if the Association approved the plan. The new Executive Committee, chaired by Dr. Byrd, gave such approval. On 27 June 1950 a new ad hoc committee consisting of Dr. H. M. Phillips, Chairman, Dr. J. H. Fincher, and Dr. G. W. Jeffers, was appointed by President Byrd to formulate regulations for governing and for awarding a Meritorious Service Award. The following report was submitted by the committee and approved by the Association.

Meritorious Service Award: A cash award of one hundred dollars ($100.00) sponsored by the Southern Scientific Company of Atlanta, Georgia, will be presented each year at the annual meeting of the Association of Southeastern Biologists to a member of the Association for especially meritorious and outstanding contributions to the biological sciences, involving particularly service to young people as a teacher.

Suggested Regulations

1. The recipient should be a biologist who is a member in good standing of the Association of Southeastern Biologists.
2. He should have taught biology in a southern institution for a period of at least ten years.
3. The recipient of the award will not be eligible for future awards.
4. The recipient will be selected each year by a committee designated by the Executive Committee of the Association of Southeastern Biologists.

The report then proceeded with "Suggestions Relative to Selection of Recipient." In brief these were: (1) to allow any member of ASB to nominate a candidate, with final decision to rest with majority vote of committee members; (2) general criteria for guiding the Committee: (a) progress of the candidate indicated by recognition in his institution—such as important assignments and contributions specifically related to good teaching; (b) the number of students for whom he provided primarily the inspiration to continue in biology, especially those who later received advanced degrees.

The administration of the Award was to be carried out by a committee of three members. These members shall be appointed by the President for terms of one, two and three years, after which time the current recipient of the award will replace the retiring member. The senior member will be Chairman.

At the awards ceremony of the twelfth annual meeting of ASB held at Agnes Scott College on 19 April 1952, Dr. Elon Byrd, Chairman of the Meritorious Service Award Committee, presented the first award, and sponsored prize of $100.00, to Dr. Mary Stuart MacDougall of Agnes Scott College. This inaugurated what is now considered the most prestigious award a member of the Association can receive.

For many years the Meritorious Teaching Award was sponsored by the Southern Scientific Company. Beginning in 1980 the Carolina Biological Supply Company took over the sponsorship of this award. In 1980 and 1981 the award consisted of a certificate, a bronze medallion, and $1,000.00. From 1982 to the date of this writing the award has been a certificate and $1,000.00.

All the senior scientists winning Research Prizes from 1947 through 1986, as well as all winners of the Meritorious Teaching Awards from 1952 through 1986, are listed in Table 7.

Other awards: Beginning in 1952 a handsome Research Award of $500.00, sponsored by Martin Instrument Co. of Easley, South Carolina, was made available for students. The students winning this award from 1982 through 1986 are listed in Table 8, along with the schools where their research work was carried out.

In 1985 and 1986 the *Eugene P. Odum Award,* sponsored by the Southeastern Chapter of the Ecological Society of America was won by the two persons, listed under this award, also in Table 8.

In 1986 the *North Carolina Botanical Garden Award* was first offered, and the winner of this award is also listed in Table 8.

It is presumed that the *Eugene P. Odum Award,* as well as the *North Carolina Botanical Garden Award* are both continuous offerings.

Necrology: As with our national and world populations, as the ASB membership steadily increases, it also realizes some loss in members. Sometimes this loss is due to the failure to pay dues; sometimes by moves to distant places; but more often by death. Table 9 records the deaths of those members whose decease has been noted in *The Bulletin,* since its beginning in 1954, and certainly does not include nearly all members who have died in that interval. In addition to name, the Table records, where available: the years of birth and death; the exact date of death; and the institution being served at time of death, or retirement. Also recorded, at the extreme right in brackets is the Volume and Number of the *ASB Bulletin* in which notice of the death is recorded. In many cases leaders in the Association, or leaders in their own institution, have had fairly extensive obituaries accompanying the death notice.

Cooperating societies: The Southeastern Section of the Botanical Society of America, and the Southern Appalachian Botanical Club, have held their annual meetings with the ASB, regularly, since the inception of the latter. There are other biological organizations which meet with ASB with more or less regularity, and others that do so more sporadically. Most of the members of these other societies are also members of ASB. The programs of these other societies are meshed with the ASB program, in annual meetings. They sometimes separate into sectional programs, and often combine in jointly planning a symposium, a teaching forum, or other programs in which two or more groups have a joint interest.

In regard to the annual meeting of the ASB it was mentioned that originally there were only two regular adherents: The Southeastern Section of the Botanical Society of America; and The Southern Appalachian Botanical Club. In more recent years the Southeastern Region of Beta Beta Beta, and The Southeastern Chapter of the Ecological Society of America, have met with the ASB with great regularity. The Southeastern Society of Parasitologists in even more recent years has become an almost regular member of the annual meeting group. In addition to these five, practically regular adherents, there are other organizations which meet with ASB periodically. These include: the Southeastern Branch of the Society of American Bacteriologists; the South Atlantic Chapter of the Society of Wetlands Scientists; the Kentucky-Tennessee Branch of the Society of American Bacteriologists; the Regional Section of the National Association of Biology Teachers; the Crustacean Society; the Southeastern Division of the American Society of Ichthyologists and Herpetologists; the Southeastern Fishes Council, and occasionally others.

In other words, the ASB is becoming more and more like a Southeastern AIBS, or perhaps more accurately a Southeastern IBS. As more and more societies become associated with ASB, the membership of the latter continues to increase. The official figure—from the Treasurer's office—for the ASB membership in mid-December 1986 was 1350.

More about meetings: A more lengthy history could make an interesting study of several aspects of annual meetings, looking beyond the regular programs.

A listing of the various symposia held over the years would make for one such study. Titles; speakers; objectives; conclusions! Favorable response to earlier symposia have led to an increasing part of our total program being devoted to these. The titles to some of the interesting and informative symposia presented in recent meetings have been: (1) Biota, Ecology and Ecological History of Cedar Glades; (2) Plant Genetic Engineering: Update and Teaching Undergraduates; (3) Barrier Islands; (4) Mississippi River Delta Lakes; (5) Demographic Studies of Plant Species; and many, many more.

Another such study could be a listing and analysis of the various banquet speeches made over the years. Quite a few of the earlier banquet speakers were by distinquished biologists from beyond the southeastern area. One exceptionally interesting talk, this writer remembers, was by the late Edgar Anderson, of Shaw's Garden. It was an exposé of the origin and evolution of *Rosa alba* and the genetic contribution of that species to the development of the modern rose. Perhaps more of the banquet talks have been by past presidents of the ASB. Some of these latter have spoken on their favorite subject, such as "spiders." Some have spoken on their biological theories. Some on educational and teaching aspects of biology. It should make for some fun to really study, and if possibly analyze, such a potpourii of subjects as one would find.

A consideration of the many field trips taken over the years should be interesting. To such places as Stone Mountain of Georgia, under the guidance of the very knowledgeable, Dr. W. B. Baker. Or to the Peaks of Otter, of Virginia—before there was any safe, easy, road to the top. Or the trip at Tuscaloosa under the guidance of that rare old botanist, Roland Harper (Fig. 4), a trip that our past President and Editor, Jim Hardin, remembers so well. Or to Red River Gorge, and many other places!

Or just the reminiscence of social hours spent 'after hours' with some of the "grand old men" (and women) of southeastern biology. Some were truly "char-

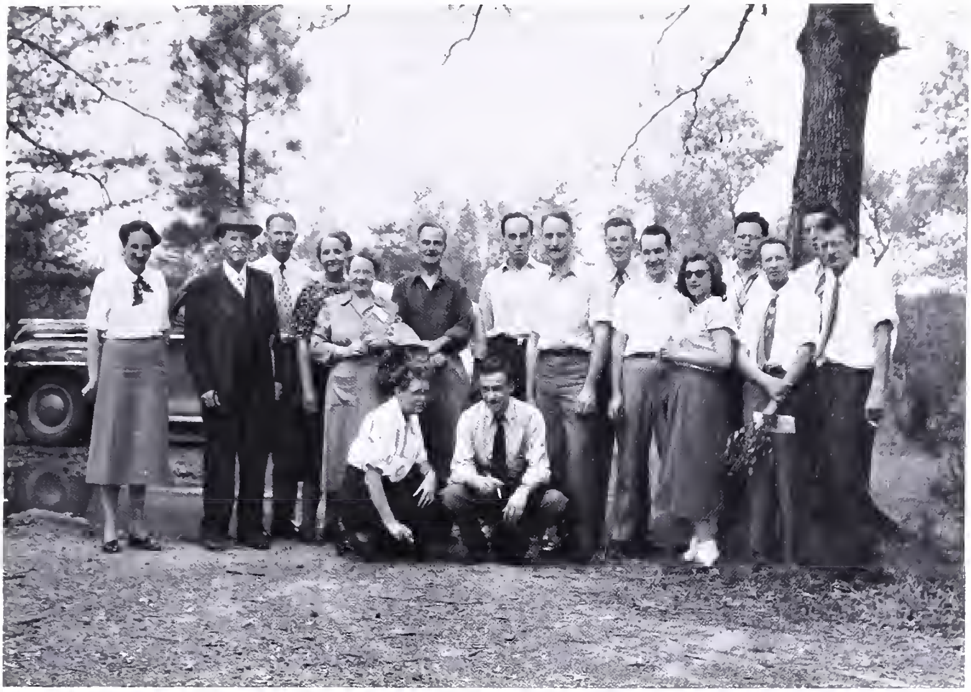

Fig. 4. A group of ASB members on a field trip at the time of the Twelfth Annual Meeting at the University of Alabama, April 1951. The field trip was led by *Roland Harper* (2nd from left). Such ASB stalwarts as *Royal Shanks, Jim Hardin* (both Past Presidents), and *Earl Core* (Meritorious Teacher Award winner) can be recognized. Others in the group are E. Ford, R. Gilpin, R. Shuster, L. Arnold, and F. Norris.

acters"—in the best sense of the word. Conversational hours spent with some of these were more educational than the programs. Hours spent with such persons as "Doc" Howell, Orland White, B. W. Wells, Bruce Reynolds, Elon Byrd—and on and on. Mostly long dead now—with the "Younger generation" not knowing what they missed.

ASB programs are fine, and constantly improving. What was anticipated could be gained in southern biology, by an association such as the ASB has met with much realization. But what is suggested in the first part of this section is that information alone is not all that has been gained from our Association, and our meetings. The fellowship and friendships fostered with colleagues in other schools of our region—as suggested by Dr. Boyd and Dr. Reynolds, are very important byproducts of our membership in ASB.

Table 1. Institutions and cities hosting annual meetings of the Association of Southeastern Biologists, 1937–87.

1937	Athens	University of Georgia
1938	Athens	University of Georgia
1939	Durham	Duke University
1940	Nashville	Vanderbilt University
1941	Auburn	Alabama Polytechnic Institute
1942	Miami	University of Miami
1946	Columbia	University of South Carolina
1947	Atlanta	Emory University
1948	Gainesville	University of Florida
1949	Knoxville	University of Tennessee
1950	Charlottesville	University of Virginia
1951	Tuscaloosa	University of Alabama
1952	Atlanta	Agnes Scott College
1953	Chapel Hill	University of North Carolina
1954	Baton Rouge	Louisiana State University
1955	Charleston	The Citadel
1956	Durham	Duke University
1957	Athens	University of Georgia
1958	Tallahassee	Florida State University
1959	Knoxville	University of Tennessee
1960	New Orleans	Loyola University
1961	Lexington	University of Kentucky
1962	Winston-Salem	Wake Forest College
1963	Gainesville	University of Florida
1964	Atlanta	Emory University
1965	Charlottesville	University of Virginia
1966	Raleigh	North Carolina State University
1967	Columbia	University of South Carolina
1968	Athens	University of Georgia
1969	Memphis	Memphis State University
1970	Lakeland	Florida Southern College
1971	Richmond	Richmond Universities
1972	Mobile	University of South Alabama
1973	Bowling Green	Western Kentucky University
1974	Savannah	Georgia Southern College
1975	Blacksburg	Virginia P.I. & State University
1976	New Orleans	University of New Orleans
1977	Raleigh	North Carolina State University
1978	Tuscaloosa	University of Alabama
1979	Chattanooga	U.T. Chattanooga
1980	Tampa	University of South Florida
1981	Knoxville	University of Tennessee
1982	Richmond (KY)	Eastern Kentucky University
1983	Lafayette	University of Southwestern Louisiana
1984	Memphis	Memphis State University
1985	Murfreesboro	Middle Tennessee State University
1986	Columbia	University of South Carolina
1987	Athens	University of Georgia

Table 2. Meeting places, by state and city (numbers indicate times of meeting).

- Alabama
  - Auburn 1
  - Mobile 1
  - Tuscaloosa 2
- Florida
  - Gainesville 2
  - Lakeland 1
  - Miami 1
  - Tallahassee 1
  - Tampa 1
- Georgia
  - Athens 5
  - Atlanta 3
  - Savannah 1
- Kentucky
  - Bowling Green 1
  - Lexington 1
  - Richmond 1
- Louisiana
  - Baton Rouge 1
  - Lafayette 1
  - New Orleans 2
- North Carolina
  - Chapel Hill 1
  - Durham 2
  - Raleigh 2
  - Winston-Salem 1
- South Carolina
  - Charleston 1
  - Columbia 3
- Tennessee
  - Chattanooga 1
  - Knoxville 3
  - Memphis 2
  - Murfreesboro 1
  - Nashville 1
- Virginia
  - Blacksburg 1
  - Charlottesville 2
  - Richmond 1

Table 3. ASB Presidents and Vice-Presidents, 1937–87.

	Presidents	Vice-Presidents
1937–38	George H. Boyd	H. L. Blomquist
1938–39	E. E. Reinke	H. R. Totten
1939–40	H. L. Blomquist	J. Speed Rogers
1940–41	R. C. Rhodes	Mary S. MacDougall
1941–42	A. S. Pearse	James T. Penney
1942–46	Mary S. MacDougall	R. O. Christenson
1946–47	James T. Penney	Elon E. Byrd
1947–48	Martin D. Young	Howard M. Phillips
1948–49	Samuel L. Meyer	Eugene P. Odum
1949–50	Howard M. Phillips	H. B. Sherman
1950–51	Elon E. Byrd	George C. Kent, Jr.
1951–52	W. M. A. Deacon H. P. Sturdivant	H. P. Sturdivant
1952–53	Margaret N. Hess	C. S. Shoup
1953–54	Bruce D. Reynolds	Alvin V. Beatty
1954–55	H. R. Totten	Fred T. Wolf
1955–56	A. V. Beatty	Aaron J. Sharp
1956–57	George C. Kent, Jr.	Paul M. Patterson
1957–58	H. K. Wallace	Horton H. Hobbs
1958–59	Mary Esther Gaulden	Victor A. Greulach
1959–60	Horton H. Hobbs	Royal E. Shanks
1960–61	Victor A. Greulach	Walter S. Flory
1961–62	Royal E. Shanks	E. Ruffin Jones, Jr.
1962–63	Walter S. Flory	Robert T. Brumfield
1963–64	E. Ruffin Jones, Jr.	Harold J. Humm

Table 3. Continued.

	Presidents	Vice-Presidents
1964–65	William D. Burbanck	Elsie Quarterman
1965–66	Harry J. Bennett	B. Theodore Cole
1966–67	Elsie Quarterman	Wilbur H. Duncan
1967–68	Harold J. Humm	Margaret Y. Menzel
1968–69	Robert B. Short	James W. Hardin
1969–70	John M. Carpenter	James N. Dent
1970–71	C. W. Hart, Jr.	Leland Shanor
1971–72	Grover C. Miller	David J. Cotter
1972–73	Leland Shanor	John D. Withers
1973–74	David J. Cotter	Dorothy C. Bliss
1974–75	James N. Dent	John M. Herr, Jr.
1975–76	Perry Holt	Madeline P. Burbanck
1976–77	John M. Herr, Jr.	Franklin F. Flint
1977–78	Madeline P. Burbanck	Clarence E. Styron
1978–79	Raymond O. Flagg	Beryl C. Franklin
1979–80	James W. Hardin	J. Frank McCormick
1980–81	Franklin F. Flint	Margaret L. Gilbert
1981–82	J. Frank McCormick	Donald J. Shure
1982–83	Margaret L. Gilbert	J. Kenneth Shull, Jr.
1983–84	Charles E. Jenner	Mary C. Dunn
1984–85	J. C. O'Kelley	Lafayette Frederick
1985–86	Lafayette Frederick	Rebecca R. Sharitz
1986–87	Donald J. Shure	William H. Martin

Table 4. Secretary-Treasurers, Secretaries, and Treasurers, 1937–87.

	Secretary-Treasurers		
1937–38	James T. Penney	1947–48	Samuel L. Meyer
1938–42	D. C. Broughton	1948–49	Elon E. Byrd
1942–46	Martin D. Young	1949–51	Alvin V. Beatty
	Secretaries		
1951–55	Mary Esther Gaulden	1969–70	Dorothy Crandall Bliss
1955–57	J. C. Dickinson	1973–76	James C. McDonald
1957–61	Harold J. Humm	1976–79	Jerry M. Baskin
1961–64	Harry J. Bennett	1979–82	Carol C. Baskin
1964–67	Margaret Y. Menzel	1982–85	Rebecca R. Sharitz
1967–69	Dorothy L. Crandall	1985–88	Sandra T. Bowden
	Treasurers		
1951–56	J. Paul Reynolds	1968–72	David J. Cotter
1956–59	A. W. Jones	1972–77	Ray O. Flagg
1959–62	Elsie Quarterman	1978–83	J. C. O'Kelley
1962–65	Leland Shanor	1984–89	R. L. Beckmann
1965–68	John Carpenter		

Table 5. Elected members of the Executive Committee, 1937–87.

1937–38	Margaret N. Hess
1937–38	A. S. Pearse
1937–38	E. E. Reinke
1937–38	J. S. Rogers
1937–40	Mary S. MacDougall
1938–39	H. R. Hessler
1938–40	Herman Kurz
1938–41	J. T. Penney
1938–42	R. O. Christenson
1939–41	A. S. Pearse
1939–42	E. E. Reinke
1940–46	E. E. Byrd
1940–46	J. F. W. Pearson
1941–42	Martin D. Young
1941–43	F. A. Wolf
1942–46	Samuel L. Meyer
1942–47	C. M. Pomerat
1946–47	Margaret N. Hess
1946–48	H. K. Wallace
1946–49	C. L. Baker
1946–49	Herman Kurz
1947–48	Bruce D. Reynolds
1947–50	E. Ruffin Jones
1948–50	Fred T. Wolf
1948–51	E. L. Bishop
1948–51	Margaret N. Hess
1949–52	D. M. Brown
1949–52	Bruce D. Reynolds
1950–53	E. C. Cocke
1950–53	Thelma Howell
1951–54	Josephine Bridgeman
1951–54	Royal E. Shanks
1952–53	Paul Reynolds
1952–55	George C. Kent, Jr.
1953–55	John A. Fincher
1953–56	Horton H. Hobbs
1953–56	Gordon Wolcott
1954–57	Harold J. Humm
1954–57	Ruth M. Jones
1955–58	R. T. Brumfield
1955–58	J. G. Carlson
1956–59	Walter S. Flory
1956–59	I. S. Kitchin
1957–60	Donald C. Scott
1957–60	Harry E. Wheeler
1958–61	William Burbanck
1958–59	Elsie Quarterman
1959–60	J. C. O'Kelley
1959–62	Eugene Odum
1959–62	Robert B. Short
1960–61	James Gregg
1960–63	B. T. Cole
1960–63	C. E. Jenner
1961–62	Victor M. Cutter
1961–64	Walter Herndon
1962–64	Patrick H. Yancey
1962–65	C. Ritchie Bell
1962–65	John H. Carpenter
1963–66	Wilbur H. Duncan
1963–66	G. M. Jeffrey
1964–67	David J. Cotter
1964–67	Chauncey G. Goodchild
1964–68	Frederick T. Wolf
1965–68	Julian T. Darlington
1965–68	Robert B. Short
1966–69	Richard E. Garth
1966–69	Grover C. Miller
1967–70	Burton J. Bogitsh
1967–70	Anna Josephine Bridgeman
1968–71	Albert E. Radford
1968–69	John D. McCrone
1969–71	John H. Mullahy
1969–72	Perry C. Holt
1969–72	Charles Ray, Jr.
1970–73	James Dent
1970–72	John D. Withers
1972–73	Richard E. Garth
1971–74	Arthur W. Cooper
1971–74	Joseph F. Fitzpatrick
1972–75	Edward E. C. Clebsch
1972–75	John M. Rawls
1973–74	John M. Herr, Jr.
1973–76	Carl D. Monk
1974–76	Clarence E. Styron
1974–77	Gary E. Dillard
1974–77	Joseph C. O'Kelly
1975–78	John R. Bozeman
1975–78	Beryl C. Franklin
1976–79	J. Frank McCormick
1976–79	Rudolph Prins
1977–80	Jon R. Fortman
1977–80	George M. Simmons, Jr.
1978	John H. Mullahy
1978–80	Linda M. Stroud
1979–81	James L. Riopel
1979–82	Samuel B. Jones, Jr.
1979–82	George S. Ramseur
1980–81	Donald J. Shure
1980–83	Mary C. Dunn
1980–83	James F. Matthews
1981–84	Lafayette Frederick
1981–84	Sharon Patton
1982–85	William C. Grant
1982–85	Paul Yokley, Jr.
1983–86	W. H. Martin
1983–86	Joe E. Winstead
1984–87	Carol C. Baskin
1984–87	Courtney T. Hackney
1985–88	Janice C. Coffey
1985–88	David H. Rembert, Jr.
1986–89	Michael J. Baranski
1986–89	Nancy C. Coile

Table 6. The ASB Bulletin. Editors; Business Managers; Circulation Managers; Assistants.

	Editors	
Victor A. Greulach	1954–58	Volumes 1–5
Geoffrey M. Jeffery	1959–60	Volumes 6–7
C. Willard Hart, Jr.	1961–72	Vol. 8, No. 1–Vol. 19, No. 2
Margaret Y. Menzel	1972–77	Vol. 19, No. 3–Vol. 24, No. 2
Gary E. Dillard	1977–80	Vol. 24, No. 3–Vol. 27, No. 2
James W. Hardin	1980–86	Vol. 27, No. 3–Vol. 33, No. 2
Frank J. Schwartz	1986–	Vol. 33, No. 3–
	Associate Editors	
J. C. Dickinson		Vol. 2, No. 2–Vol. 5, No. 1
Harold J. Humm		Vol. 5, No. 2–Vol. 8, No. 2
Harry J. Bennett		Vol. 8, No. 3–Vol. 11, No. 2
Margaret Y. Menzel		Vol. 11, No. 3–Vol. 14, No. 2
Dorothy L. Crandall Bliss		Vol. 14, No. 3–Vol. 17, No. 2
Margaret Gilbert		Vol. 17, No. 3–Vol. 20, No. 2
James C. McDonald		Vol. 20, No. 3–Vol. 23, No. 2
Jerry M. Baskin		Vol. 23, No. 3–Vol. 26, No. 2
Carol C. Baskin		Vol. 26, No. 3–Vol. 29, No. 2
Rebecca R. Sharitz		Vol. 29, No. 3–Vol. 32, No. 2
Sandra T. Bowden		Vol. 32, No. 3–
	Assistant Editors	
Betty Ursomarso		Vol. 10, No. 3–Vol. 12, No. 4
Betty Peddicord		Vol. 13, No. 1–Vol. 14, No. 2
	News Editors	
John F. Fitzpatrick, Jr.		Vol. 14, No. 1–Vol 17, No. 2
Jean Pugh		Vol. 17, No. 3–Vol. 19, No. 2
Crawford Jackson		Vol. 19, No. 3–Vol. 21, No. 2
Jon Fortman		Vol. 21, No. 3–
	Business Managers	
J. Paul Ryenolds		Vol. 2, No. 2–Vol. 3, No. 1
A. W. Jones		Vol. 3, No. 2–Vol. 6, No. 2
Elsie Quarterman		Vol. 6, No. 3–Vol. 9, No. 2
Leland Shanor		Vol. 9, No. 3–Vol. 12, No. 2
John Carpenter		Vol. 12, No. 3–Vol. 16, No. 2
David J. Cotter		Vol. 16, No. 3–Vol. 18, No. 2
Ray O. Flagg		Vol. 18, No. 3–Vol. 24, No. 4
J. C. O'Kelly		Vol. 25, No. 1–Vol. 30, No. 4
R. L. Beckman		Vol. 31, No. 1–
	Circulation Managers	
Roger J. Hollis		Vol. 2, No. 2–Vol. 5, No. 4
Dorothy Hubbard		Volume 19, No. 4–
	Assistant Circulation Manager	
Ann Foster Blevins		Vol. 4, No. 3–Vol. 5, No. 4

Table 7. ASB awards to senior scientists.

	ASB Research Prize	Meritorious Teacher
1947	Clyde E. Keeler	
1948	Shirley H. Taylor	
1949	H. A. Crumley & S. L. Meyer	
1950	Margaret Y. Menzel	
1951	N. Harrington & R. Koza	
1952	Clyde E. Keeler	Mary MacDougall
1953	Billen, Stapelton & Strehler	Orland E. White
1954	William J. Brett	Woolford Baker
1955	Jerome O. Krivanek	John N. Couch
1956	Asa A. Humprhies, Jr.	Hugo Blomquist
1957	James H. Gregg	Ezda M. Deviney
1958	Charles E. Jenner	Henry R. Totten
1959	J. A. Miller & F. S. Miller	Margaret N. Hess
1960	A. V. Beatty & J. W. Beatty	Ora C. Bradbury
1961	William D. Burbanck	Warren Deacon
1962	Burton J. Bogitsh	Septima C. Smith
1963		Patrick Yancey
1964	A. V. Beatty & J. W. Beatty	Ruskin S. Freer
1965	George G. Brown	H. P. Sturdivant
1966	C. E. DePoe & E. O. Beal	Charles Ray, Jr.
1967	R. E. Totten & H. B. Howe, Jr.	H. J. Oosting
1968	Henry C. Aldrich	Wade T. Batson
1969	Paul Yokley, Jr.	Wm. L. Mengebier
1970	Joseph C. O'Kelley	Elton C. Cocke
1971	P. Haysman & H. B. Howe, Jr.	Earl L. Core
1972	R. E. Gant & E. E. C. Clebsch	Aaron J. Sharp
1973	Paul F. Terranova	H. H. Hobbs, Jr.
1974	H. R. Delcourt & P. A. Delcourt	Grace J. Thomas
1975	D. C. Lagrew & J. M. Baskin	L. M. Outten
1976	V. M. Norton & K. B. Davis	Jonathan J. Westfall
1977	B. P. Howard & W. B. Keith	Margaret L. Gilbert
1978	Walter S. Flory	Albert E. Radford
1979	Robert E. Gant & E. E. C. Clebsch	Eugene P. Odum
1980	Jeffrey C. Luvall & George T. Weaver	Robert B. Short
1981	Steven W. Seagle	William D. Burbanck
1982	Jon M. Stucky & R. L. Beckman	Fred H. Norris
1983	M. R. Willig, T. Lacher & M. A. Mares	Frederick T. Wolf
1984	J. W. Ross, R. H. Suehisa & H. Y. Yamamota	Robert H. Mohlenbrock
1985	J. Dan Pittillo & H. R. Delcourt	Margaret Y. Menzel
1986	J. S. Fralish	Lafayette Frederick

Table 8. Other ASB awards.

Student Research Award (Sponsored by Martin Instrument Co., Easley, S.C.)	
1982	Lawrence J. Davenport, Univ. Alabama
1983 (tie)	Nat B. Frazer, Univ. Georgia Lawrence P. Rozus, UNC Wilmington
1984	G. Frank Yelverton, UNC Wilmington
1985	Phillip E. Ryals, Univ. Alabama
1986	Michael O. Moore, Univ. Georgia

Eugene P. Odum Award (Sponsored by S.E. Chapter, Ecological Society of America)	
1985	Marina C. Joranovich, Univ. Alabama Birmingham
1986	Gary P. Shaffer, L.S.U.

North Carolina Botanical Garden Award	
1986	Gary L. Walker, Univ. Tennessee

Table 9. Necrology (Past Presidents indicated by *).

Adams, Joseph E.	1903–81	June 9, 1981	UNC-CH (28-4)
Arnold, Paul, Jr.	1896–1964		Univ. Jacksonville (11-4)
Beal, Ernest O.	1928–80	Aug. 31, 1980	W Ky Univ. (28-1)
Beatty, Alvin V.	1909–70	Feb. 11, 1970	Emory (17-2)
*Bennett, Harry J.	1904–84		LSU (31-3)
Betts, Edwin	1892–1958	Sept. 27, 1958	Univ. Va (6-1)
Bishop, Everett	1916–76	Mar. 25, 1976	Univ. Ala (25-3)
*Blomquist, Hugo L.	1888–1964	Nov. 28, 1964	Duke (12-1)
*Boyd, George H.	1891–1965	Dec. 30, 1965	Univ. Ga (13-2)
Brown, Clair A.	1903–82	Mar. 24, 1982	LSU (29-4)
*Byrd, Elon E.	1905–74	Mar. 3, 1974	Univ. Ga (21-4)
Cagle, Fred R.	1915–68	Aug. 8, 1968	Tulane (13-4)
Cochran, Doris M.		May 20, 1968	Smithsonian (15-4)
Cocke, Elton C.	1901–75	Jan. 23, 1975	WFU (23-1)
Coker, W. C.		June 27, 1953	UNC-CH (1-1)
Conrad, G. Miles	1911–64	Sept. 9, 1964	Biol Abs (11-4)
Cramer, Ardis L.	(Member 1966–80)	1980	Atlanta Ga (28-1)
Cutter, Victor M., Jr.	1917–62	Feb. 26, 1962	UNCG (9-2)
Deviney, Ezda	1895–1964	Mar. 19, 1964	Fla State (11-4)
Dijkman, Marinus J.	1907–70	Oct. 6, 1970	Univ. Miami (18-1)
Doerpinghaus, S. L.		Jan. 19, 1968	Agnes Scott (15-3)
Goethe, Charles M.	1875–1965	July 1965	(12-3)
Goldstein, Lewis C.	1917–1985	Sept. 25, 1985	Va Comm (32-2)
Good, Henry G.	1897–1964	April 10, 1964	Auburn (11-4)
Goodchild, C. G.	1912–80		Emory (27-3)
Gray, Irving E.	1897–1982		Duke (30-3)
Gray, Netta E.	1913–70	Aug. 24, 1970	Agnes Scott (18-1)
*Greulach, Victor A.	1906–85		UNC-CH (32-3)
Hesler, Lexemuel R.	1888–1977		Univ. Tenn (25-3)
Howell, Thelma	1901–79	Sept. 23, 1979	Highlands (27-1)
Hunt, Ernest L.	1919–78	July 8, 1978	Emory (25-4)
Husband, D. D.	1939–86	April 21, 1986	Univ. S. Car (33-4)
Husted, Ladley	1906–69	Mar. 26, 1969	Univ. Va (16-4)
Ingram, Byron R.		Aug. 3, 1977	Clemson (25-1)
Jeffreys, Donald B.	1925–85		ECU (32-3)
*Jones, E. Ruffin, Jr.	1905–76	Sept. 11, 1976	Univ. Fla (24-4)
Jones, Ruth M.	1900–76		Winthrop (25-3)
Kuehne, Robert A.	1927–85		Univ. Ky (32-3)
Kurz, Herman	1886–1965	Dec. 16, 1965	Fla State (13-2)
Lancaster, L. Y.	1893–1980	May, 1980	W Ky Univ. (28-1)
Lauter, Felix	1919–80	May 22, 1980	Univ. S Car (28-1)
Lockwood, Lewis B.		Aug. 28, 1980	W Ky Univ. (28-1)
Lowrey, George H., Jr.	1913–78		LSU (25-4)
Lewis, Ivey F.	1882–1964	Mar. 16, 1964	Univ. Va (11-4)
McCollum, R. E.		Oct. 1, 1972	Roanoke (20-2)
McDaniel, James S.	1933–78	Nov. 26, 1978	ECU (26-3)
McGaha, Y. J.	1910–76		Univ. Miss (25-3)
McIntyre, R. A., Jr.	1926–76		Campbell (25-3)
Matthews, Velma Dare	1904–58	Jan. 7, 1958	Coker (5-1)
Mobberly, William C.		Jan. 3, 1968	NELaS (15-3)
Morris, D. M., Jr.	1917–75		Miami (25-3)
Mullahy, Fr. J. H.	1914–78	May 16, 1978	Loyola (25-4)
O'Dell, Herman	1907–69	Oct. 1969	E Tenn (16-4)
Olewine, Donald A.	1928–82		Ga Soth (29-3)
Overcash, H. B.	1894–1966		Hampden-Sydney (13-4)
*Pearse, Arthur S.	1877–1956	Dec. 11, 1956	Duke (4-2)

Table 9. Continued.

Penn, George H.	1918–63	May 10, 1963	Tulane (10-3)
Pennington, Tully S.	1913–82	July, 1982	Ga Soth (29-3)
*Penney, J. T.	1900–64	Mar. 29, 1964	Univ. S Car (10-4)
Peterson, Glen E.	1926–85		MStU (32-1)
*Phillips, Howard M.	1910–86	Mar. 26, 1986	S Ala (33-3)
Rawls, John R.		1980	S Ala (27-3)
*Reynolds, Bruce D.	1894–1957	April 26, 1957	Univ. Va (4-2)
Richardson, Annie L.	1923–84		Norfolk St (32-1)
Sarvella, Patricia A.	1926–77		USDA (25-4)
*Shanks, Royal E.	1912–62	Aug. 4, 1962	Univ. Tenn (9-4)
Sisk, Morgan E.		1976	(25-4)
Strickland, John C.	1915–80	Feb. 23, 1980	Richmond (27-3)
Sullivan, Robert L.	1928–86	Nov. 4, 1986	WFU
Tipton, Samuel R.		1982	Univ. Tenn (29-3)
Viosca, Percy, Jr.	1892–1961	Aug. 29, 1961	La (9-1)
Walton, Lucille		1985	Mt. Lake (32-3)
Ward, Helen L.	1910–82		Lafayette, Ind (29-3)
Wells, Bertram W.	1884–1978	Dec. 29, 1978	NCSU (26-3)
White, Orland E.	1885–1972	Jan. 10, 1972	Univ. Va (19-4)
Williams, Bert C.	1909–54	July 6, 1954	Univ. Ala (1-3)
Withers, John D.	1922–72	Sept. 30, 1972	AIBS (20-1)
Wolf, Frederich Adolph	1885–1975	Nov. 1, 1975	Duke (23-3)
Yancey, Patrick H., S.J.	1920–69	Oct. 1969	Sp Hill (17-2)
Yarbrough, John A.	1905–82		Meredith (30-3)

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The ASB BULLETIN

Volume 34, Number 3 July 1987

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The Official Quarterly Publication of
The Association of Southeastern Biologists

ASB BULLETIN

(ISSN 0001-2386)

The ASB Bulletin, established in 1954 as the official quarterly publication of the Association of Southeastern Biologists, a non-profit scientific and educational association, is published in January, April, July, and October at Lawrence, Kansas. All contributions should be sent to the Editor. News items should be sent to the News Editor. Inquiries about missing numbers and other circulation matters should be addressed to the Circulation Manager. Subscription orders for institutions should be sent to the Business Manager. Subscription rate for non-members of ASB is $25.00 per year. Printing and typography by Allen Press, Inc., Lawrence, Kansas 66044. Second class postage paid at Philadelphia, PA and additional mailing office.

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Associate Editor: Dr. Sandra Bowden, Department of Biology, Agnes Scott College, Decatur, GA 33030
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1988: Janice Coffey Swab, Department of Science, St. Mary's College, Raleigh, NC 27611
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1989: Michael Baranski, Department of Biology, Catawba College, Salisbury, NC 28144
Nancy Coile, Curator, University of Georgia Herbarium, Athens, GA 30602
1990: G. W. Gibbons, Savannah River Ecology Lab, Aiken, SC 29802
Diane R. Nelson, East Tennessee State University, Johnson City, TN 37614

The ASB encourages, in the broadest and most liberal sense, the advancement of biology as a science by: the promotion of research, the increase and diffusion of knowledge of biology, emphasis of the relationship of fundamental knowledge of biology to the solution of biological problems, the preservation of biological resources, and by its meetings, reports, discussions, and publications to promote scientific interests and inquiry, thereby adding to the health, happiness, and knowledge of all peoples. The Association meets annually on campuses of universities and colleges located throughout the southeast. Affiliated organizations meeting with the Association are: Southern Appalachian Botanical Club, Southeastern Section of the Botanical Society of America, Southeastern Region of Beta Beta Beta, South Atlantic Chapter of the Society of Wetlands Scientists, Southeastern Chapter of the Ecological Society of America, Southeastern Division of the American Society of Ichthyologists and Herpetologists, Southeastern Fishes Council, and Southeastern Society of Parasitologists. The ASB has representation in Section G Committee of the AAAS. Varying types of membership are available to individuals and institutions. Members receive the Bulletin.

TIME AND PLACE OF FUTURE MEETINGS

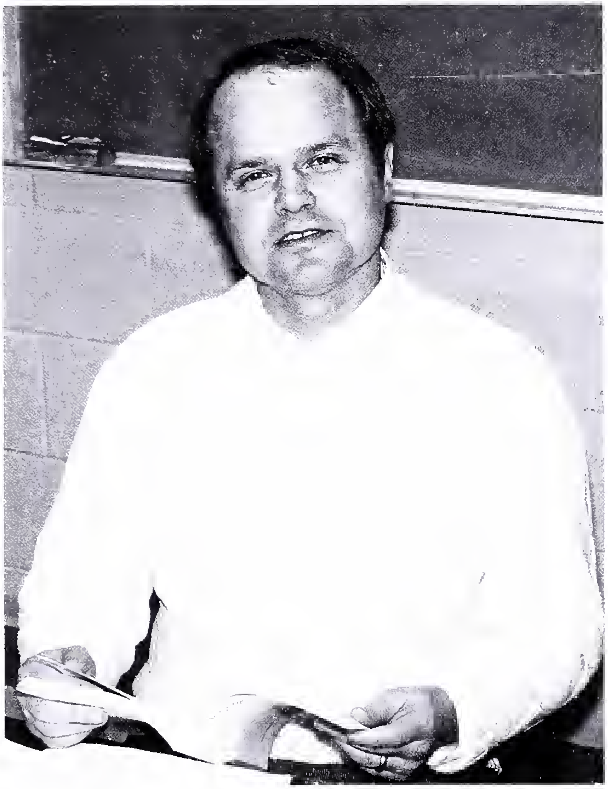
1988	April 13–15	Co-Hosts: University of Southern Mississippi and Gulf Coast Research Laboratory, Biloxi, MS
1989		University of North Carolina–Charlotte, NC
1990	April 19–21	Towson State University, Towson, MD

PATRON MEMBERS

Carolina Biological Supply Co., Burlington, NC
Martin Microscope Co., Easley, SC

ASSOCIATION AFFAIRS

1987 MERITORIOUS TEACHING AWARD



Dr. Stewart Ware

This citation honors Dr. Stewart Ware of the Department of Biology, College of William and Mary, Williamsburg, Virginia with the 1987 ASB Meritorious Teaching Award. This award, which consists of a certificate and a check for $1,000 generously provided by Carolina Biological Supply Company, is a statement by ASB on the value of teaching, and a testimony by students to the respect good teaching engenders. Dr. Ware, a native of Mississippi, received a B.S. degree from Millsaps College and a Ph.D. in Botany from Vanderbilt University. He joined the College of William and Mary in 1967 and remains at that institution teaching undergraduate courses in general botany and ecology and graduate courses in synecology and biogeography. He has served as major professor for eight masters degree candidates, has served on the committees of approximately 90 graduate students, and has guided the honors research projects of about 45 undergraduates. He has been a member of ASB and several other professional organizations for many years. He founded the Botany Section of the Virginia Academy of Science and served as editor of the Academy's journal. He currently serves as editor of *Castanea.* His numerous publications mainly deal with upland forest ecology.

Dr. Ware's letters of support attest to his dedication to teaching and his ability to stimulate intellectual curiosity. His students cite his careful and articulate class presentations and his willingness to spend time outside the classroom advising them. They cite his concern for their personal and academic development, and in all cases, they express their respect and affection.

1987 RESEARCH AWARDS

The *ASB Research Award* to faculty members was presented to W. H. Murdy *et al.* abstract 110 (see ASB Bulletin Vol. 34, No. 2, 1987 for abstract) on Regulation of the timing of pollen germination by the pistil in *Talinum mengesii.*

The *Student Research Award,* sponsored by the Martin Microscope Company of Easley, South Carolina, was presented to C. M. Smith and C. Hackney (abstract 228) on Effects of hydrocarbon covered substrate on intertidal recruitment of *Crassostrea virginica.*

The *Eugene P. Odum Award,* sponsored by the southeastern chapter of the Ecological Society of America, was presented to R. Lau and D. R. Young (abstract 165) on The effect of integration on the water relations and survivorship of the clonal understory herb.

The *North Carolina Botanical Garden Award* was presented to R. B. Hulk (abstract 250) on the Phytogeography of endemic Labiates of the southeastern United States.

Byrd Award, sponsored by the Southeastern Society of Parasitologists, was presented to C. T. Faulkner and S. Patton (abstract 156) on the Analysis of paleofecal samples from Big Bone cave, Van Buren County, Tennessee.

Graduate Student Support Awards were presented to 18 applicants to help them with costs associated in attending the annual meetings. The number following each name refers to the abstract number as found in ASB Bulletin Vol. 34, No. 2, 1987.

All, T. M., Tennessee Technological University, TN (114)
Crumby, W. D., Tennessee Technological University, TN (142)
Kanehl, P. D., Tennessee Technological University, TN (148)
King, M. A., Virginia Commonwealth University, VA (151)
Lau, R. R., Virginia Commonwealth University, VA (165)
Methven, A. S., University of Tennessee, TN (257)
Moser, M. L., North Carolina State University, NC (140)
Orvos, D. R., Virginia Polytechnic Institute and State University, VA (152)
Peterson, M. S., University of Southern Mississippi, MS (80)
Quisenberry, S., Tennessee Technological University, TN (143)
Ross, S. W., North Carolina State University, NC (75)
Smith, C. M., University of North Carolina–Wilmington, NC (228)
Thomas, R. L., James Madison University, VA (182)
Turner, L. D., Tennessee Technological University, TN (72)
Tupaez, E. G., Old Dominion University, VA (39)

Webb, M. A., Tennessee Technological University, TN (4)
West, S. K., Old Dominion University, VA (41)
Winner, B. L., University of North Carolina–Wilmington, NC (147)

Appreciation Award plaques were presented during the 50th anniversary banquet to the Carolina Biological Supply Company and Martin Microscope Company for their long term interest and support of ASB activities.

1987 COMMERCIAL EXHIBITORS

Associated Microscope, Elon College, NC 27244
Beckman Instruments, Norcross, GA 30092
Bio-Rad Laboratories, Stone Mountain, GA 30087
Wm. C. Brown Publishers, Dubuque, Iowa 52001
Carolina Biological Supply Company, Burlington, NC 27215
Clark Tech, Knoxville, TN 37923
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E. I. DuPont Company, Atlanta, GA 30340
Georgia Instruments, Inc., Atlanta, GA 30341
Halco Instruments, Inc., Atlanta, GA 30307
Martin Microscope Company, Easley, SC 29640
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PARCO Scientific Company, Vienna, OH 44473
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Wadsworth Publishing Company, Belmont, CA 94002
Worth Publishers, Inc., New York, NY 10003
Southern Micro Instruments, Inc., Atlanta, GA 30339

NECROLOGY

J. G. Arnold, Jr., New Orleans, LA 70119
M. C. Dunn, Middle Tennessee State University, Murfreesboro, TN 37130
D. Husband, Department of Biology, Univ. South Carolina, Columbia, SC 29208
A. B. Stump, Cross Hill, SC 29332

ASB ENRICHMENT FUND

The society approved and established the ASB Enrichment Fund at the business meeting 10 April 1987. Contributions and checks destined for this fund should be sent to Dr. R. Beckmann, Department of Botany, North Carolina State University, Raleigh, NC 27695. The Board of trustees was charged with overseeing the direction and expenditures of this fund.

OTHER BANQUET ACTIVITIES

The society recognized the 19 past presidents that attended the meetings at the annual banquet. Several charter members also in attendance were recognized.

THE ASSOCIATION OF SOUTHEASTERN BIOLOGISTS TREASURER'S REPORT

1 January 1986–31 December 1986

I. SAVINGS ACCOUNT			
A. Merrill-Lynch Ready Assets Trust			
Balance January 1, 1986	$10,096.91		
Net Transfers to/from Checking	(7,000.00)		
Interest Earned 1986	440.51		
	3,547.51		
II. CHECKING ACCOUNT			
Balance on Hand, January 1, 1986	369.22		
A. Receipts			
Regular Dues/Subscriptions	10,799.48		
Annual Meeting	5,227.66		
Bulletin Page Charges	294.00		
Honorarium Reimbursement (Bot. Soc. America)	100.00		
Abstract Forms	21.00		
Interest	92.76		
TOTAL RECEIPTS		$16,534.90	
TOTAL RECEIPTS & BEGINNING BALANCE			16,904.12
B. Disbursements			
1. Membership Cultivation			
Printing & Mailing, Call for Dues	164.38		
Printing & Mailing, Call for Papers	626.52		
		$ 790.90	
2. Publication			
ASB Bulletin (Vol. 33), Printing	17,582.56		
Roll Maintenance for Bulletin Mailing	255.73		
		$17,808.29	
3. Office Expenses			
Treasurer	150.00		
Editor	7.00		
Stationery Printing	39.30		
Bank Charges	57.00		
		$ 253.30	
4. Travel and Related Expenses			
Student Travel Awards	1,412.00		
Speaker Honorarium/Travel	585.74		
N. C. Botanical Garden Award	100.00		
Plaques	91.05		
		$ 2,188.79	
5. Research Awards		$ 1,000.00	
TOTAL			22,041.28
NET TRANSFERS TO/FROM SAVINGS			(7,000.00)
TOTAL DISBURSEMENTS			15,041.28
BALANCE IN CHECKING December 31, 1986			1,862.84
SUMMARY			
CASH IN CHECKING			1,862.84
CASH IN SAVINGS			3,537.42
TOTAL ASSETS			$ 5,400.26

EDITOR'S REPORT TO ASB FOR 1986

Volume 33 of the ASB Bulletin for 1986 consisted of 226 pages, 86 more than in Volume 32. Dr. Hardin, former editor, edited the journal through number two or 118 pages. I edited numbers three and four for a total of 108 pages. Abstracts of the Barrier Island symposium were featured in number three while the 10 paper Cedar Glades symposium contributed to the bulk of number four.

The ASB Bulletin is slowly being modernized by eliminating much of the black on the cover and in section headings. Instead a black lettering and logo constitute the new white cover giving it a refreshing lighter outlook. Only manuscript submissions and limited printing budget keep the Bulletin from reaching it's full potential.

The good news is that Allen Press, in our new three year contract, has agreed to hold, subject to postage and material cost increases, our printing charges for 1987 at 1986 levels. Several items such as changes per line reset, stuffing, and shipping costs will be increased modestly in 1988 and 1989. These actions encourage the Society to retain Allen Press as printer of the Bulletin for three or more years. Further, this new contract permits the Society to plan ahead and make adjustments in their dues structure, thereby keeping the Society on sound footing and permitting expansion of the journal by the printing of more manuscripts, symposia, etc., as they are accepted for publication.

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REVIEWS

Schofield, W. B. 1985. **Introduction to Bryology**. Macmillan Publ. Co., 866 Third Avenue, New York, NY 10022. $45.00. 431 p.

The aim of the author is an inclusive introduction to the bryophytes. He starts the reader off with a chapter which provides even the novice with the basis for an understanding of the information in the remainder of the book. A large amount of information about this fascinating group of plants is presented. The author can only be commended for the approach because it has produced a comprehensive book.

Over half of the book is concerned with the systematic groups of the bryophytes. The subclasses of the mosses are treated with individual chapters. This section of the book is introduced with a general chapter on the Musci and is closed with a summary chapter, "Evolutionary Trends and Interrelationships among the Mosses." The Hepaticae are treated in a similar fashion except that the various orders of hepatics are considered in separate chapters. The Anthocerotae are discussed in a single chapter. The sections of a typical chapter on an order or a subclass consider the spores and spore germination, gametophyte, sporophyte, evolution and relationships, ecology, and generalizations. All chapters of the book end with a bibliography of relevant literature.

The remaining chapters consider non-structural approaches to the bryophytes. Information from historical, cytological, chemical, physiological, ecological, and geographical investigations is given in these chapters. The book is completed with an excellent glossary and several appendices giving pertinent methods and information for studying the bryophytes. The final appendix is a listing of manuals for the identification of bryophytes from all parts of the world.

This book is an excellent treatment of the bryophytes. There is no question that it will promote interest in the mosses and liverworts. The writing of the author and the organization of the book produce enjoyable reading. There is a wealth of information presented in a clear manner and the bibliographies provide easy access to the literature for more detailed information. The author and the publisher must be congratulated on the illustrations. They are excellent and their selection effectively complements the text. This book is a must for anyone with an interest in bryophytes. In addition, it would be an excellent addition to the library of any botanist because it would serve as a source book on the mosses and liverworts for someone specializing in other aspects of plant science.

Dean P. Whittier, *Department of General Biology, Vanderbilt University, Nashville, TN 37235.*

Burr, B. M. and M. L. Warren, Jr. 1986. **A Distributional Atlas of Kentucky Fishes.** Kentucky Nature Preserves Commission, Frankfort, KY. $10.00. 398 p.

Burr and Warren treat 16 introduced and 226 described and undescribed native species of Kentucky fishes. Each species account consists of a dot map of Kentucky occurrence and an inset of North American distribution. Narrative for each account presents additional distributional comments such as unusual, erroneous, or unverified records and relative abundance. A "Systematics" section treats relationships, recent or anticipated nomenclatorial changes, subspecies or lack thereof, and etymology of the scientific name. The "Habitat" section has a few sentences describing the species' usual haunts. Conservation status in Kentucky (endangered, threatened, etc.) is discussed for appropriate species. No illustrations of fishes are provided other than the cover plate of *Etheostoma rafinesquei*, the only fish whose native range lies within Kentucky and an outline drawing (or two) for each family. A color frontpiece depicts a breeding male *Etheostoma barranense.* Introductory pages cover the organization and purpose of the book, history of Kentucky ichthyology, physiography, and description of Kentucky's river systems and significant tributaries. A rather lengthy and detailed discussion of Kentucky fish zoogeography follows the species accounts, and the 14-pages of literature citations contain over 200 entries, many from 1985 and 1986.

The book is remarkably free of typographical (I did not find one) and factual errors. Distribution maps are attractive and locality dots and drainage patterns are sufficiently bold to provide an immediate visual impression, but the inset of North American distribution is a bit too small. Plotted localities are conservative, but very complete and will not result in problems created in the North American Atlas (Lee, *et al.,* 1980) where uncertain localities were often included, stick-on locality dots were occasionally transposed inadvertently, and valid records were often not included. In at least one instance (*Noturus elegans,* p. 175) the authors are perhaps ultraconservative in describing the Bauer and Branson (1979) record from Little Sandy system as "doubtful." The two specimens (University of Tennessee 48.238), collected by Bauer and Branson, certainly represent *Noturus elegans,* and were carefully checked against the remote possibility that they might represent an extension of *N. trautmani* to south of the Ohio River.

The authors closely follow nomenclature of Robins *et al.* (1980), but not to a fault. They consider recent suggestions for name changes and phylogenetic reassessment, and incorporate many. For example, Moronidae replaces Percichthyidae, bullheads are placed in *Ameiurus* rather than *Ictalurus,* Fundulidae and Elassomatidae are treated as families, *Atractosteus* is treated as a valid genus for the alligator gar, *Fundulus dispar* is recognized as valid, and phylogenetic placement of salmoniforms and Cottidae reflects results of recent work. Many (but surely not all) of these changes are likely to be incorporated into the 1990 revision of the "names list." On the other hand, the rainbow trout remains as *Salmo gairdneri* in spite of overwhelming evidence that, however politically unpopular, the species epithet must be *mykiss* (see Okasaki, 1984).

The Habitat and Conservation Status sections are generally informative and reflect the authors' extensive familiarity with Kentucky fishes. The key word section under Habitat seems to detract from the narrative habitat descriptions.

Congratulations to Brooks and Melvin and the Kentucky Nature Preserves Commission. The Kentucky fishes atlas is superbly done, attractive, complete, inexpensive, informative, and virtually error free. As is probably apparent, I strained considerably to find a few minor negative comments.

Literature Cited

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Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister, and J. R. Stauffer, Jr. (eds.) 1980. Atlas of North American freshwater fishes. North Carolina St. Mus. Nat. Hist., Raleigh. 254 p.

Okasaki, T. 1984. Genetic divergence and its zoogeographic implications in closely related species *Salmo gairdneri* and *Salmo mykiss.* Jap. J. Ichthy. 31-297-310.

Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea, and W. B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. Fourth ed. Am. Fish. Soc. Spec. Pub. 12: 1–74.

David A. Etnier, *Department of Zoology, University of Tennessee, Knoxville, TN 37996-0810.*

R. L. Tate III, editor. 1986. **Microbial Autecology: A Method for Environmental Studies.** John Wiley & Sons, New York. $42.50. 266 p.

Microbial Autecology is a 10 chapter compendium dealing with a variety of disciplines and technologies. Included are: established and novel approaches to taxonomic studies, an introduction to the use of computers in autecological studies, the use of genetic variants for research, soil and aquatic ecological studies as well as an introduction to environmental microbial autecology. From an aquatic perspective, I found chapters 7 (Autecological Studies on Marine Ecosystems, by R. Y. Morita) and 8 (Autecological Studies in Microbial Limnology, by C. W. Boylen and R. J. Sarocco) of particular interest.

Despite taxonomic, physiologic, environmental, and evolutionary complexities characterizing studies aimed at elucidating the roles individual microbial species and populations play within the context of a functional ecosystem, microbial autecology has progressed greatly in the relatively short span of 20–30 years following development and deployment of appropriate field and laboratory technology. Prior to the 1940's, aquatic microbiologists were largely committed to properly and accurately identifying numerically-dominant species in natural waters, and when possible, developing effective culturing techniques necessary for initiating studies on environmental regulation of growth, reproduction, and basic metabolic processes (photosynthesis, respiration, mineralization of organic compounds). Absence of biotechnological, radiochemical, and analytical methodology applicable to studies of natural populations, let alone ecosystems, virtually confined all pioneering efforts at identifying physical-chemical and biotic regulation of microbial physiology and productivity to the laboratory. This necessitated overly simplistic and unnatural settings in order to complete experimental protocols. Despite such technical shortcomings, several milestone studies deployed simplistic yet applicable and relevant methods to examine ionic and salinity requirements: Mudrak 1933; Bukatsch 1936, impacts of surficial vs. planktonic (free-floating) conditions; ZoBell and Anderson 1936; Stark *et al.* 1938, hydrostatic pressure; ZoBell and Johnson 1949, as well as impacts of organic matter enrichment on natural microbial growth potentials and species composition Stark *et al.* 1938; Heukelekian and Heller 1940.

These breakthrough studies were largely confined to marine environments, despite the fact that the oceans are often chronically deficient in organic and inorganic nutrients essential for attaining sufficient and analytically detectable microbial growth. Nutrient enriched freshwater habitats, which by and large exhibit high diversities and standing stocks of biogeochemically and ecologically important microbial species, remained unexploited until the mid to late 1950's.

Such studies generated both keen interest and confidence in examining physical-chemical as well as biotic interactions with microbial populations in natural habitats. The most important conceptual driving force (which is curiously omitted in both chapters) responsible for addressing the importance of microbes in biogeochemical production and cycling processes, was a handful of ecosystem-level papers exemplifying the need for recognizing and understanding tropho-dynamic interactions and exchanges responsible for regulating productive, energy and matter cycling characteristics of natural waters. Among these, Redfield's (1934) biogeochemical contribution "On the proportions of organic derivatives in sea water and their relation to the composition of plankton" and Lindeman's (1942) introduction to the ecosystem concept "The trophic-dynamic aspect of ecology," helped create the conceptual and experimental framework for appreciating and examining microbial autecology in natural waters.

As illustrated throughout both chapters, the more recent (1960–80's) development of a variety of techniques capable of characterizing naturally-occurring populations and their activities have greatly facilitated experimental work, allowing microbial ecologists to examine regulatory, productive and cycling characteristics either *in situ* or under naturally-occurring circulation (mixing), irradiance, thermal, and chemical (nutrients and major ions as well as dissolved gases) conditions. These techniques include: the diverse applications of radioisotopes and microautoradiography for process localization and quantification, the deployment of microelectrodes and redox indicators as well as immunochemical labeling within the context of small-scale (μm–mm) microbial habitats (microzones), stable isotope methodology for examining nitrogen cycling, and a variety of electron microscopic and x-ray emission techniques for visually and chemically characterizing aquatic microbial populations and their habitats. Considering the recent infusion of technology, I must agree with the conclusion shared by both chapters that aquatic microbial autecology, while still in its infancy, is rapidly expanding as a central discipline in marine and freshwater biogeochemical as well as trophic studies.

Both chapters handily stress these recent developments in microbial autecology. Perhaps, because of the broader interdisciplinary nature of limnology, particularly when considering aquatic biogeochemical cycling coupled to terrestrial (watershed) processes, the wide array of trophic states available for investigation as well as logistic advantages to examining lakes, streams, and wetlands as opposed to vast oceanic environments, Boylen and Soracco's chapter clearly exhibits more breadth and offers excellent insight into the application of relevant technology and concepts. A comprehensive list of physical-chemical as well as biotic interactions in diverse microbial habitats, such as surface-associated microzones, specific planktonic regimes, sediments, microbial mats and interfaces is thoroughly discussed as particularly suitable for autecological studies in the limnology chapter. Morita has more specifically concerned himself with research problems and marine habitats among which he has made highly significant contributions. Included are: salinity effects, impacts of thermal regimes, hydrostatic pressure effects in deep-sea communities, hydro-thermal vent ecology, oligotrophy and nutrient starvation and the microbial utilization of diverse organics. Ironically, some of the more exciting novel autecological topics being addressed in marine microbial ecology today have been omitted. These include: 1) nutrient regeneration and transfer characteristics among protist autotrophic and heterotrophic producers and their protist (microflagellate and protozoan) consumers prior to consumption by higher ranked animal consumers (the "microbial loop" concept), 2) environmental regulation and limitation of nitrogen cycling (specifically N_2 fixation, denitrification, inorganic vs. organic nitrogen assimilation) among vast sections of the world's oceanic and coastal regions which exhibit chronic

N-deficiencies, 3) relative importance of "internal" vs. external nutrient loading and cycling in planktonic and benthic habitats, 4) roles of surface-associated microzones, including "marine snow" in nutrient cycling and production, 5) importance of microbially-mediated water column-sediment nutrient exchange, 6) recent advent and application of immunological techniques capable of identifying metabolically-distinct microbial species and their specific enzyme systems, 7) biodegradation of toxins, 8) symbioses and their functional role in ecosystems, and 9) factors controlling dormancy among heterotrophs and autotrophs.

An equivalent number of biogeochemically as well as ecologically distinct and important problems face marine as opposed to freshwater microbiologists, despite the fact that the oceans are often nutrient-depleted and hence less productive than inland waters. Microbial autecology will continue to clearly distinguish itself as an integral discipline in both marine and freshwater studies, since vital questions concerning production of organic matter, its immediate and long-term fate, the regulation of production and cycling processes by physical-chemical and biotic factors and the understanding of man's impact on trophic states and resultant water quality are intimately tied to microbial processes.

Both chapters are complementary perspectives, relating past developments to current trends and accomplishments as well as future needs in microbial ecology. They are well-written, reasonably balanced (Boylen and Soracco's chapter excels in this respect) and, within the context of microbial autecology, indispensable. I highly recommend both chapters as auxiliary reading material for biological oceanography and limnology courses, whereas the entire book serves as an excellent reference for microbial ecologists, deserving serious consideration as a textbook in upper-level undergraduate and graduate microbial ecology courses.

LITERATURE CITED

Bukatsch, F. 1936. Uber den Einfluss von Salzen auf die Entwicklung von Bakterien. Sbr. Akad. Wiss. Wien, Math.-Naturw. kl. Abt. I 145: 259–276.

Heukelekian, H. and A. Heller. 1940. Relation between food concentration and surface for bacterial growth. J. Bacteriol. 40: 547–558.

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ZoBell, C. E. and F. H. Johnson. 1949. The influence of hydrostatic pressure on the growth and viability of terrestrial and marine bacteria. J. Bacteriol. 57: 179–289.

HANS W. PAERL, *Institute of Marine Sciences, University of North Carolina, Morehead City, NC 28557.*

Atkinson, L. P., D. W. Menzel, and K. A. Bush (eds.) 1985. **Oceanography of the Southeastern U.S. Continental Shelf.** Am. Geophys. Union. Coastal Estuarine Sci. 2. 156 p.

When I was asked to review "Oceanography of the Southeastern U.S. Continental Shelf" by Atkinson, Menzel, and Bush, I felt a little like a preacher being asked to lecture on the manufacture of scotch whiskey. My field is geological oceanography, the book is about physical, chemical and biological oceanography, and the audience of this review consists primarily of ecologists. Nevertheless I accepted the task because I had purchased the book for my reference collection, before being asked to review it, and a review by an interested marine scientist who is not in the mainstream of the book's topics may be worthwhile.

The book comprises 12 chapters: an introduction; four chapters on various aspects of the physical oceanography; a chapter on hydrography and nutrients; four biological chapters that cover: (1) phytoplankton, (2) zooplankton, (3) bacteria, and (4) macroinfauna; a chemical chapter on trace metals; and a summary chapter that includes future plans. Much of the science presented in this volume is the result of the authors' investigations in the South Atlantic Bight (SAB) between 1975 and the early

1980's that was funded largely by the Department of Energy and the Minerals Management Service (formerly Bureau of Land Management).

The SAB extends from Cape Hatteras southwards to West Palm Beach, Florida. It is a complex patch of ocean to investigate: it is bounded by the dynamic Gulf Stream on its eastern side, strongly influenced by synoptic wind events of a few days' duration with the passage of cold fronts, river input is important but diffuse, and the region extends from subtropical waters in the south to temperate waters in the north. Many of the authors approached these complexities by splitting the SAB into three regions: the inner, middle, and outer shelf, and determining, comparing, and contrasting the major factors influencing their observations within each of these regions.

I found the book to be very informative, well-organized, and uniformly well-written. It is evident that the authors of the various chapters communicated extensively with one another before and during the preparation of this volume. There are common themes that recur in several chapters that help tie the book together, e.g., the importance of river runoff on the inner shelf, and the influence of productivity pulses generated by Gulf Stream intrusions during spring and summer months. The chapter on hydrography and nutrients by L. P. Atkinson is a particularly informative chapter that includes numerous diagrams of temperature and salinity distributions as well as cross-shelf sections of oxygen and nutrients. The chapter on zooplankton by Paffenhofer also was exceptionally clear, well-illlustrated and interesting to read: the dependence of zooplankton populations on advective processes is acute in the SAB.

All of the chapters were presented clearly, but some lacked basic information that would have been of general interest. The chapter on tides, for example, covers the characteristics of tidal ellipses at several stations in great detail, yet lacks a diagram or table on tidal ranges down the coast and across the shelf. The chapter on macroinfauna would have been more interesting if maps of benthic biomass, total organic carbon in the sediments, and perhaps sediment grain size had been included (although their distributions may have been too patchy to allow this). The chapter on phytoplankton lacks information on the relative abundances of the major diatoms and other phytoplankters that are found in different regions. The book also would have been strengthened by a good bathymetric chart of the SAB, a chapter on the geology and, in a few places, clearer illustrations.

Despite some of these shortcomings, this volume is a must for any marine scientist working in the SAB. This collection of papers serves as a good general source of information with an extensive and valuable list of references for further reading. I am glad that I bought the book, and I expect to refer to it often.

THOMAS C. JOHNSON, *Duke University Marine Laboratory, Beaufort, NC 28516.*

NEWS OF BIOLOGY IN THE SOUTHEAST

Jon R. Fortman—*News Editor*
Division of Science and Mathematics
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ABOUT PEOPLE AND PLACES

Alabama

University of North Alabama, Biology Department. Dr. Jack Moore was recently appointed as Dean of Arts and Sciences leaving the vacancy of Department Head. Paul Yokley replaces in that position. Dr. Paul Kittle recently completed a project to establish an interpretive nature trail at King Spring Wildlife Sanctuary in Florence, Alabama, home of population of the Tuscumbia darter. The project involves the Shoals Audubon Society of which Dr. Kittle is president.

Florida

Archbold Biological Station, Lake Placid. Ron Myers, former ABS Research Biologist, was appointed a Research Associate and will continue his long-term studies on the effects of fire on Station plant communities. *Susan Boettcher* resigned from her position as Research Assistant in Plant Ecology, and will be attending graduate school at the University of Kentucky.

University of Florida, Department of Wildlife and Range Sciences. Dr. Jeffrey Lincer, Scientific Advisor for the Sarasota Board of County Commissioners, has been named Adjunct Associate Professor. *Dr. Lincer*'s association with the University of Florida will provide him with additional resources to identify and facilitate the research that is currently underway at the Ringling-MacArthur Reserve east of Sarasota.

Georgia

Department of Natural Resources, Natural Heritage Inventory. The Georgia Natural Heritage Inventory is a comprehensive computer assisted statewide ecological inventory and atlas of the natural ecological diversity of Georgia. The program is administered by the Game and Fish Division. Anyone interested in the GNHI as a volunteer contributor or desiring additional information, please contact: GNHI, Route 2, Box 119D, Social Circle, GA 30279. (404) 557-2514.

Louisiana

Louisiana State University, Department of Botany. Dr. G. Bruce Williamson was elected Vice President-Education by the Board of Directors of the Organization for Tropical Studies. *Dr. David J. Longstreth* was elected to a 3-year term in the Southern Section of the American Society of Plant Physiologists. The Department of Botany will add two new members to the graduate faculty in the 1987–1988 academic year. *Dr. William J. Platt,* currently at the Tall Timbers Research Station in Florida, will join the plant ecology group. *Dr. Terry Bricker,* currently an assistant professor at the University of Southern Mississippi, will join the developing faculty group in plant cellular, molecular, and developmental biology.

Tulane University, Department of Biology. Dr. Julie Denslow has joined the department as tropical ecologist. She is conducting research in Costa Rica and her research interest is tree falls. *Dr. Ken Muneoka* is the new developmental biologist, and studies amphibian development and experimental embryology of embryos within the uterus of rodents.

Mississippi

Mississippi University for Women, Division of Science and Mathematics. Dr. Jon Fortman was recently honored by the Mississippi Legislature as part of a Recognition Program to honor an outstanding faculty member from each of the State Universities.

North Carolina

Appalachian State University, Department of Biology. Dr. Wayne Van Devender is currently serving as president of the North Carolina Herpetological Society. *Dr. Frank Randall* was recently appointed to the Non-Game Advisory Committee of the North Carolina Wildlife Resource Commission.

East Carolina University, Department of Biology. Three members of the faculty have retired. They are: *Dr. Patricia Daugherty,* Spring 1986; *Dr. Everett Simpson,* Fall 1986, and *Dr. Graham Davis,* Summer 1987.

Wake Forest University, Department of Biology. Dr. Robert L. Sullivan died of cancer on 4 November 1986. Trained as a geneticist, *Dr. Sullivan* was committed to excellence in undergraduate education. A fund has been established as a memorial and *Dr. Sullivan* has bequeathed a substantial gift to the department to continue his commitment to undergraduates. He had been on the faculty since 1962.

South Carolina

Erskine College, Department of Biology. Dr. Douglas E. Facey has joined the department as an Assistant Professor. *Dr. Facey* comes from the Zoology Department at the University of Georgia. He will have charge of physiology and ecology courses and will continue research into physiological adaptation in animals. *Janice Haldeman,* Associate Professor of Biology received the President's Award for the best graduate paper granted by the South Carolina Branch of the American Society for Microbiology.

University of South Carolina, Department of Biology. Dr. Roger H. Sawyer was appointed Chairman of the Department of Biology on 1 October 1986. Professor *David H. Rembert, Jr.,* member of the executive council of ASB, has been appointed associate chairman of the department. His chief responsibility is to develop and coordinate the undergraduate curriculum. On 27 December 1986, the national officers of the Beta Beta Beta Biological Honor Society voted in favor of establishing a new chapter, designated the Tau Mu Chapter, and has since been formally accepted by the other chapters in its district.

Francis Marion College, Department of Biology. Dr. Tom Roop, Professor of Biology, has been named South Carolina Science Educator of the Year by the South Carolina Science Council. *Roop* was presented the "Helms Award" at the annual meeting. The award is given annually to an individual who has done outstanding work with the state's science teachers.

Tennessee

East Tennessee State University, Department of Biological Sciences. Dan M. Johnson has been chosen as new editor for Selysia, a Newsletter of Odonatology, maintaining a sense of community among dragonfly scholars around the world. *Denise Pav* has been named the Program Director of ETSU Medical College Admission Test Review Program.

Virginia

Old Dominion University, Department of Biological Sciences. The following faculty have been added: *Dr. Robert Ratzlaff* (Immunologist), *Dr. Ralph Stevens* (Reproductive Biologist), and *Dr. Christopher Osgood* (Geneticist).

Virginia Commonwealth University, Department of Biology. Dr. Charles R. Blem, Professor of Biology, has been elected Editor of the Wilson Bulletin.

ABOUT MUSEUMS AND BOTANICAL GARDENS

Georgia

Savannah Science Museum. The Museum received a grant from the South Carolina Heritage Trust Program to research the status of the flatwoods salamander and broad-striped dwarf siren in the four counties where they had been previously found.

Kentucky

Museum of History and Science, Louisville. The Museum is the recipient of a $450,000 matching grant from the National Endowment for the Humanities in Washington, D.C. The Museum has also received a $10,000 grant from the Gannett Corporation, and may be used in the matching grant from the National Endowment.

Louisiana

Lafayette Natural History Museum, Planetarium and Nature Station. The exhibit hall will present "Discover Science" during June 30 through August 23, 1987. The Planetarium will feature "The Soviet Space Program" from June 30–Oct. 11.

SPECIAL FIELD TRIP INFORMATION

The *Southeastern Chapter* of the *Ecological Society* field trip will occur 25–27 September 1987 in east-central Florida at the Kennedy Space Center. Trip covers barrier island complex, coastal plant communities, and wetlands. Information will be furnished on housing and specific arrangements. Contact *Ross Hinkle*, Phone 305-853/3281, Mail code Bio-2, Kennedy Space Center, Fl 32899.

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The ASB BULLETIN

Volume 34, Number 4

October 1987

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The Official Quarterly Publication of
The Association of Southeastern Biologists

ASB BULLETIN
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The ASB Bulletin, established in 1954 as the official quarterly publication of the Association of Southeastern Biologists, a non-profit scientific and educational association, is published in January, April, July, and October at Lawrence, Kansas. All contributions should be sent to the Editor. News items should be sent to the News Editor. Inquiries about missing numbers and other circulation matters should be addressed to the Circulation Manager. Subscription orders for institutions should be sent to the Business Manager. Subscription rate for non-members of ASB is $25.00 per year. Printing and typography by Allen Press, Inc., Lawrence, Kansas 66044. Second class postage paid at Philadelphia, PA and additional mailing office.

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The ASB encourages, in the broadest and most liberal sense, the advancement of biology as a science by: the promotion of research, the increase and diffusion of knowledge of biology, emphasis of the relationship of fundamental knowledge of biology to the solution of biological problems, the preservation of biological resources, and by its meetings, reports, discussions, and publications to promote scientific interests and inquiry, thereby adding to the health, happiness, and knowledge of all peoples. The Association meets annually on campuses of universities and colleges located throughout the southeast. Affiliated organizations meeting with the Association are: Southern Appalachian Botanical Club, Southeastern Section of the Botanical Society of America, Southeastern Region of Beta Beta Beta, South Atlantic Chapter of the Society of Wetlands Scientists, Southeastern Chapter of the Ecological Society of America, Southeastern Division of the American Society of Ichthyologists and Herpetologists, Southeastern Fishes Council, and Southeastern Society of Parasitologists. The ASB has representation in Section G Committee of the AAAS. Varying types of membership are available to individuals and institutions. Members receive the Bulletin.

TIME AND PLACE OF FUTURE MEETINGS

1988	April 13–15	Co-Hosts: University of Southern Mississippi and Gulf Coast Research Laboratory, Biloxi, MS
1989		University of North Carolina–Charlotte, NC
1990	April 19–21	Towson State University, Towson, MD

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PRESIDENT'S CORNER
A VIEW FROM HERE

This year, 1987–88, marks the 51st year of *The Association of Southeastern Biologists*, the beginning of its second half-century of activity in the biological sciences. This is an important time in the history of our society and an opportunity to reflect on the present status of the *Association* and to plan for the future. We can take definite pride in our success in promoting research and teaching and the conservation of biological resources in the Southeast. Those who have served the ASB as officers or committee members, who have participated in the annual meetings, and who have supported the Association's activities should feel proud of their roles in meeting our objectives. I would like to express my personal appreciation to Donald Shure for his active and effective leadership as President last year, especially his efforts in establishing the ASB Enrichment Fund and developing and directing our recent 50th Anniversary meeting in Athens.

The first half-century of the ASB saw a remarkable growth from the 58 founding members at the University of Georgia in 1937 to more than 1,600 members when we returned to Athens (for the 5th time) to celebrate our 50th year. Over the years the ASB has attained considerable stability as an organization and has become recognized as one of the largest and most active regional societies of professional biologists in the United States.

Our 50th Anniversary was truly a milestone for the Association. Throughout the meetings, we celebrated our past and planned for the future. The historical review prepared by Walter Flory and printed as a supplement to the *ASB Bulletin* described the early beginnings of the society and its role throughout the years in fostering teaching and research in the biological sciences. We established an Enrichment Fund to provide the society greater opportunity and resources in the future to promote research and teaching through special awards, honoraria and student support. A very special aspect of this meeting was that it brought together 19 past presidents of the ASB, early members (including Wilbur Duncan, a charter member), and many long-term active members in the *Association*.

Several special activities at the meeting brought attention to the value and importance of protecting our biotic resources. The urgent and vivid plenary message of Dan Janzen, who described remarkable and heroic efforts to re-establish an area of tropical dry forest, reminded us of how vital it is that we preserve natural ecosystem functions and maintain biological diversity. One of the most exciting events was our approval of a resolution in support of legislative efforts to designate a portion of the Great Smoky Mountains as wilderness, and thus to protect the biota of this unique portion of our biological heritage. The excellent symposia, paper and poster presentations involving ASB members and representatives of eight affiliate societies, and the field trips and social activities succeeded in making this a memorable event. We are indebted to the members of the Local Arrangements Committee for their outstanding efforts.

ESTABLISHMENT OF ENRICHMENT FUND

We begin our second 50 years of the ASB with a very significant event, the establishment of the Enrichment Fund. This is an extremely important activity for the society, for it will enhance the educational and research objectives of the ASB and provide the resources for encouraging and rewarding excellence in the biological sciences. Through the extensive efforts of William Grant and the *ad hoc* Endowment Committee, guidelines and procedures for the Enrichment Fund have been developed and implemented.

The ASB Enrichment Fund will support activities, such as scholarship awards and research opportunities for graduate and undergraduate students, research prizes for especially meritorious papers presented at the annual meetings by students and by senior scientists, awards to encourage excellence in graduate research and teaching, travel awards to assist students with expenses at the annual meetings, and other educational objectives. Such activities are essential to the goal of the ASB in contributing to the advancement of biological sciences and the development of professional biologists in the Southeast.

Contributions to the ASB Enrichment Fund may be made in three categories, (1) a general fund devoted to the educational and research objectives of the ASB, (2) a restricted fund to support a specific educational activity, and (3) an endowment to provide long-term support for specific objectives and activities. Named endowments may be established in honor or in memory of a distinguished colleague or family member.

I think it noteworthy that in a very forward-looking action at the 50th Anniversary meeting, the ASB members voted to establish this Enrichment Fund and incorporate it into the Bylaws of the society. Now it is up to us, as members, to support this fund and invest in the future of ASB! I encourage you to consider what ASB has meant to you and your students over the years and what you might be willing to provide to enhance the financial support and long-term future of the ASB activities. Please send your contributions and pledges to Robert Beckmann, ASB Treasurer.

STATUS OF *ASB BULLETIN*

In addition to the Enrichment Fund, two other activities will be given special attention this year. The status and future development of the *ASB Bulletin* is being evaluated. In recent years, the *Bulletin* has printed several special volumes (such as the Cedar Glades symposium in the October 1986 issue), has published a limited number of research papers, and has served as an effective means of transmitting information about ASB activities. This year, an *ad hoc* Publications Committee of members of the Executive Committee will join Editor Frank Schwartz in examining the role of the *Bulletin* and ways to develop it into an even more effective journal for the society.

AFFILIATED SOCIETIES

This year we will also focus our attention on ways the ASB can more fully meet the needs of all biologists in the Southeast. We were pleased that eight affiliate societies met with us in Athens and participated in all aspects of the program. We are considering ways of strengthening interactions with those societies meeting annually with ASB through regular attendance of one of their officers at ASB Executive Committee Meetings and by soliciting recommendations for individuals to serve on ASB Committees. We are also inviting other regional biological organizations to meet with us in the future.

Throughout this year, your society officers will welcome your suggestions and ideas concerning ways of strengthening ASB. I also encourage you to make a commitment now to attend our next annual meeting in Biloxi, Mississippi, as we launch the Association of Southeastern Biologists on its second successful 50 years.

—Rebecca R. Sharitz, President

OBITUARY

MARGARET YOUNG MENZEL
1924–1987

On the morning of 30 May 1987 Dr. Margaret Young Menzel died after a long illness. Dr. Menzel was well known to members of the Association of Southeastern Biologists, having been an active member since 1950.

Born in Kerrville, Texas 21 June 1924, Margaret grew up in south Texas and graduated magna cum laude from Southwestern University (Texas) in 1944 with majors in Biology and English. The next year she taught Chemistry and Microbiology at Lamar College in Beaumont. She received her Ph.D. under the direction of Dr. Orland White from the University of Virginia in 1949, where she met and married Winston Menzel. At Virginia she was, as she said, a "Blandy Farmer." This time at Blandy Farm was very special to her and friendships made there persisted throughout her life. After receiving her doctorate she held appointments as Instructor of Agronomy, Texas Agricultural Experiment Station, College Station, Texas; Research Geneticist, USDA, Tallahassee, Florida; Research Associate, Associate Professor, Full Professor, and University Service Professor, Florida State University, Tallahassee. While at Florida State she directed 11 masters theses and 5 doctoral dissertations.

Margaret Menzel, in addition to being an excellent scientist, was also active in many womens rights groups. She was instrumental in founding NOW in Florida and also championed equal pay for women.

Chromosome structure, meiosis, and the evolution of genome non-homology occupied most of her research efforts in material ranging from tomatoes and *Physalis* to schistosomes and clams. Her research or other intellectual interests were never confined to one thing at a time. She once defended such wide interests by saying that, "After all, genetics is coextensive with the universe," and the frequent lively discussion at her house convinced most people that she was correct. While at College Station she formed a lasting and very productive friendship with Dr. Meta Brown. Of Margaret's 83 papers, 20 are co-authored with Dr. Brown and these form the source of much of our knowledge of cotton cytogenetics and the behavior of translocated chromosomes and the ability to quickly locate any mutation to a linkage group in these plants. She and her students made over 60,000 interspecific crosses in the genus *Hibiscus* and the information gained by the study of meiosis in the hybrids allowed her to convincingly trace the spread of the various genomes through what was Gondwanaland, demonstrating that most genomes are older than most species.

Her interests included activity in many professional societies, among them the American Genetic Association, American Society for Cell Biology, Botanical Society of America (Secretary-Treasurer, Genetic Section), Genetics Society of America, and Sigma Xi (President of the FSU chapter). Her greatest commitment to such organizations was reserved for the Association of Southeastern Biologists. Margaret served as Secretary, Editor of the *ASB Bulletin* and Vice President. She organized one symposium on Chromosome Structure and Function in 1977 and co-organized another in 1981. Her students understood that they were to attend and be active in ASB and we were introduced to the membership. At her first ASB meeting in 1950 she received the Research Award and at her last meeting in 1985 she received the Meritorious Teaching Award, thus becoming one of two people ever to receive both of these highest ASB honors.

Margaret required the same high standards of her students as she did of herself and once complained that the designations undergraduate, graduate student, assistant, associate, and full professors were all wrong. She thought the designations should be learner 1, learner 2, learner 3, etc. because, in her eyes, we are all learning. She taught by teaching us to think and demanding critical thinking about genetics and about life, whether you were a "learner 1" or a "learner 5." Margaret found support for her students when none was obvious, stood up for us (and students who were not her own) when necessary, taught not only in the classroom but also in the laboratory, field, and at regular sessions in her home. She followed our careers, visiting us, corresponding with us and, as late as March 1987, pointing out literature we should have known. Her sense of humor, infectious laugh, and sometimes irreverent observations of "pompous, self-important" people and institutions kept all contact with her very lively.

When, in 1984, Margaret learned that she had a terminal illness she called her lab colleagues together and told them that there was work to be done and little time to do it. She and her colleagues turned out 18 articles in 1985–87 and, with former students, organized the Boone Chromosome Conference in 1986. She taught us how to think and, in many ways, even in her dying, how to live.

Clare Hasenkampf, University of California, San Diego, La Jolla, CA 92093, Dwayne Wise, Mississippi State University, University, MS 39762, and Ken Skull, Appalachian State University, Boone, NC 28608.

REVIEWS

Summerfelt, R. C. and G. E. Hall (eds.). 1987. **Age and Growth of Fish.** Iowa State University Press, Ames, IA 50010. $34.95. 544 p.

Just when we thought everything was known about aging of fishes we find we are still at the cutting edge of that science. Aging of fishes studies began in 1898 by noting marks on scales. Use of daily growth rings or marks on fish otoliths as an aging method didn't occur until 1971. In the interim, most scientists assumed matters were settled following the publications of Bagenal (1974) and Prince and Pulos (1983).

Age and Growth of Fish, edited by R. C. Summerfelt and G. E. Hall, is first a tribute to Dr. K. Carlander for his many efforts to define and refine our approaches to aging of fishes. Secondly, the volume's 40 papers are an attempt to update matters pertaining to aging of fishes. The papers are divided into seven chapters: history, problems and current status, characterization of growth, variability error and bias of validation, methods, larval and juvenile fish, and applied studies. All but one of the papers deal with fishes, the last treats aging of ocean bivalves. Most of the 146 and 2 hybrid fishes (most are freshwater rather than marine) mentioned have been aged using scales or otoliths.

A major theme that pervades the volume is that a vast school of scientists still relies on or use only scales or otoliths as the primary aging structure. Likewise, we still don't know what comprises an annulus, when does it form, does it form at regular intervals or even how to define the term annulus. Only a few have dared to consider other structures or techniques as a way to age fishes, e.g. tetracycline marking, EM ultrastructure examination, glycine uptake by scales, electron microprobe analysis, computerization, digitization, etc. Disturbing is the revelation that many scientists still blindly assume, without validation, that the structures they see are true annuli. Others are debating definitions of what is an annulus. A new crop of scientists is enamored with the fascination of daily growth ring increment studies as a solution to annulus and age studies. On the other hand debate rages over use and accuracy of the Von Bertalanffy growth equation as the best way to depict growth. All still seems to be in disarray when it comes to aging fishes.

A few blemishes mar this excellent volume. The most glaring is that all paper margins are not jusitifed. This gives an uneven look to the book. Figures 4–5 (pages 20–21) and 3–4 on pages 292–295 are too dark to be of real use. A few misspellings (p. 148) exist. Occasionally a procedure is not fully explained (Scheff post hoc procedure, p. 243, also not in index). Likewise, technically the term fish should be used when referring to one species, fishes when more than one species is involved.

Thus, regardless of the vast base line data that has been amassed in past and present studies on fish aging, much remains to be resolved. New and faster accurate aging techniques need be devised. Other structures and body systems should be investigated to determine their possible use in aging studies. More marine fishes should be aged, if possible. Let's hope that it will not take another 89 years before we feel secure about our methods, definitions, etc. regarding fish aging. *Age and Growth of Fish* points us in the right direction, with diligence a new "age" awaits us.

Bagenal, T. R. 1974. The Aging of Fish. Unwin Brothers Ltd., Surrey, England. 234 p.

Prince, E. D. and L. M. Pulos (eds.). 1983. Proceedings of the International Workshop on Age Determination of Oceanic Pelagic Fishes: Tunas, Bill-fishes, and Sharks. NOAA Tech. Rep. NMFS 8, 211 p.

Frank J. Schwartz, *Institute of Marine Sciences, University of North Carolina, Morehead City, NC 28557.*

Andrewartha, H. G. and L. C. Birch. 1986. **The Ecological Web.** University Chicago Press, Chicago, IL 60601. $19.85 (paper), $35.00 (hardback). 506 p.

Few books can be all things to all people and this is no exception. The authors state that this publication is intended to be much more than a revision of their previous book published in 1954. To a great extent this is true, but the common ancestry is apparent with both volumes clearly rooted in classical ecology. As a text, *Ecological Web* is best suited for students with a good ecological foundation. The strength of the book lies in the clear integration of concrete examples with general theories. Unfortunately, much of this information might be missed by students just entering the field. Important generalizations are not the primary focus, instead *Ecological Web* is autecological in nature.

The strong genetic, population, and evolutionary approach of this book makes it a good companion text for those using many of the standard texts based on a synecology approach. Despite some different terms, *i.e.* malentities and envirograms, the book is easy to read and the logic easy to follow. Overall the book is a welcome contribution to books available for student texts and I expect it to be widely used.

Courtney T. Hackney, *Department of Biological Sciences, University of North Carolina, Wilmington, NC 28403.*

Duncan, Wilbur H. and Marion B. Duncan. 1987. **The Smithsonian Guide to Seaside Plants of the Gulf and Atlantic Coasts from Louisiana to Massachusetts, Exclusive of Lower Peninsular Florida.** Smithsonian Institution Press, Washington, DC. $45.00 (cloth), $29.95 (paper). 409 pp.

This book on "seaside plants" is designed as a guide for use by both amateur and professional to the nearly 950 species of common and conspicuous seed plants encountered along the beaches, dunes, salt and brackish marshes, estuaries, inlets, and island interiors from the Texas/Louisiana border to northeastern Massachusetts, excluding lower Florida. It fulfills its objectives admirably and beautifully.

The obvious attraction is the 160-page color section with nearly 600 color photos taken in the field. Most are excellent—not only for their beauty but for their diagnostic value. Only about two dozen are either too dark, taken too far away, or of too little contrast with the natural background to be of much use in identification. It is obvious, too, that the color reproduction of many does not do justice to the usual high quality of Wilbur Duncan's photography. The color plates have the scientific name of the species and also a number which ties them to the descriptive section where one finds the scientific and vernacular names, brief diagnostic characteristics, ecology, geographical distribution along the coasts, flowering dates, important synonymy, occasional line drawings of important features not seen in color, and sometimes comparison with related species. There is also an extensive glossary with line drawings and an easy-to-use, artificial key to genera.

Species are arranged first into three main groups—herbaceous dicots, monocots, and woody plants—then by family within each group. It is an easy arrangement to use. There are only a few printer's/author's errors and only three minor objections in the format. The first is that there are no page numbers or entry numbers (to color figure and description) for the genera in the key. This would have saved the time to look them up in the index. Second, the page headings (in both the color and description sections) indicate only one family name, although a given page may include two or three families. So, some families can be missed unless the reader is sufficiently familiar with the E&P family arrangement to know, for example, where the Solanaceae would be. Third, there is no indication, again in the page headings, which of the three sections is being treated. One can tell from about where it is in the book, but a simple acronym or symbol would have helped. It would have been easy enough to have included all appropriate family names and a symbol for group in the page headings.

The Duncans traveled over 60,000 miles to study the plants and take the pictures. An introductory section includes a very useful description of coastal physiography and ecology, present land use and vegetation, and a survey of the coasts by regions, all reflecting the personal and recent knowledge that the authors gained from their travels. There is also a welcomed and much needed tone of concern for the future of these habitats due to the alarming rate of man's exploitation and destruction of this unique environment. It is the hope of the Duncans, and of this reviewer, that users of this book will gain a greater appreciation for, and somehow aid in the preservation of at least representative areas of, our coastline with its seaside plants.

James W. Hardin, *Department of Botany, North Carolina State University, Raleigh, NC 27695-7612.*

Webster, W. D., J. F. Parnell, and W. C. Biggs, Jr. 1985. **Mammals of the Carolinas, Virginia, and Maryland.** University of North Carolina Press, Chapel Hill, NC 27514. 255 pp., range maps, and 117 colored illus.

Recognizing that most persons are familiar only with larger mammals, and that they even may not have a clear concept of just what a mammal is, the authors have written this book for the curious non-mammalogists of the Carolinas, Virginia, and Maryland. They hope to arouse awareness of the richness and abundance of the mammalian fauna and increase understanding and appreciation of the mammals of the four-state area.

A description of the physiography and habitats of the region includes mammals characteristic of each ecosystem from mountain peaks to the outer edge of the continental shelf. In fact, the perspective of the whole book is ecological—where does a species live; where does it den, nest, or roost; where does it feed and what does it eat; what are its predators? Population trends are considered in light of changes in climate and disturbance of habitats. The result for mammals varies from greater abundance to extirpation. Morphological and behavioral characteristics of mammals are discussed in another introductory chapter. This provides a background for succinct morphological diagnoses of individual species in accounts that follow.

An essay on observation and study of mammals is the epitome of the book. It considers direct observation in the wild and in parks and refuges, as well as in museums, zoos, and laboratories, and describes strategies for collection of specimens and data. It also examines the study and interpretation of signs of mammals—tracks, scratches, tooth marks, nests, excavations, remains from feeding, scats, hair, and odors.

The species accounts in the body of the book are grouped by orders, each introduced by an excellent general account of the order. The accounts of species, written in a conversational style, emphasize recognition of individual species, where to find them, and what they probably will be doing. Each account includes sections on description, distribution and abundance, habitat, and natural history. In all, 121 species are described—88 terrestrial (80 native, 8 introduced) and 33 marine.

This is a handsome, well-produced book. Its dimensions are a compact 5½ × 8½ inches, it has clear, easy to read type in a two column format, and it has a substantial binding. The illustrations, all colored photographs, are outstanding. Most species are represented in photographs that take up two-fifths of a page or a full page. Few two-page spreads in the book are without a photograph and at least one range map.

Although this book has much to commend it, and the quality of writing and editing is high, there are occasional slip-ups. For example, on p. 30, in explaining the difference between *extinction* and *extirpation,* the statement "No species of terrestrial mammal is known to have become extinct in eastern North America since this country was settled" should read, No species of terrestrial mammal that occurred in eastern North America at the time of European settlement has become extinct; p. 134, the distribution of beaver may be "sporadic at present" in the Carolinas, but in Virginia and Maryland it may occur in every habitable stream in every county; p. 142, although they may be *the* common "house" mouse in many areas, even in urban settings, there is no mention of this in the account of the deer mouse and only the barest mention for the white-footed mouse; p. 163, the range map shows the historic maximum range of the black rat rather than its current range; p. 227, "The bones of the foot are fused . . . to form cannon bones" (actually only the metacarpals and the metatarsals are fused).

More serious problems are found in the sections on marine mammals, obviously not the authors' forte since these 33 species are not afforded individual accounts as the terrestrial species are, few are illustrated, and descriptions generally are inadequate for identification at sea or on the beach. In contrast to the comparative excellence of the terrestrial sections of the book, factual errors are frequent. For example: p. 200, the gray seal is "restricted to northern Canada and Alaska" (it doesn't occur there); p. 201, the photograph labeled "Harbor seal" shows a sea lion; p. 206, "during embryonic development, [cetaceans] have a covering of hair" (actually only a few hairs on cheeks or snout); p. 208, "The minke whale is the smallest of the baleen whales" (pygmy right whale is the smallest); p. 233, "[spermaceti oil] is prized by people in the perfume industry, who use it as a fixative" (actually used as a fine machine oil and in making ointments and smokeless candles); p. 223, "Ambergris is the remains of undigested beaks of squid and octopi" (actually undigested wastes coalesced around squid and octopus beaks). For cetaceans, readers should turn to S. Leatherwood, R., R. Reeves, and L. Foster, 1983, *The Sierra Club Handbook of Whales and Dolphins,* Sierra Club Books, San Francisco.

Another problem with this book is its narrow geographic perspective. The title *Mammals of the Carolinas, Virginia, and Maryland* is very explicit. In the text, contiguous states seldom are mentioned, much less relationships with the rest of North America. The reader often is left wondering whether a species is peculiar to the Carolinas, Virginia, and Maryland or is more wide-ranging. If the reader is at all curious, recourse must be made to other sources to place species accounts in the context of whole distributions. Thus, the stand-alone, textbook approach of this guide, very nearly achieved, is defeated.

Armed with these comments, the reader of this review should not be deterred from using this book. It is an excellent handbook, well designed, and crammed with information. With it as a reference it should be possible to identify almost any terrestrial mammal encountered in the Carolinas, Virginia, or Maryland.

CHARLES HANDLEY, *Division of Mammals, Smithsonian Institution, Washington DC 20560.*

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Give copies of this to your students, colleagues, and your school librarian.

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The ASB BULLETIN

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The Official Quarterly Publication of
The Association of Southeastern Biologists

ASB Bulletin

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The ASB Bulletin, established in 1954 as the official quarterly publication of the Association of Southeastern Biologists, a non-profit scientific and educational association, is published in January, April, July, and October at Lawrence, Kansas. All contributions should be sent to the Editor. News items should be sent to the News Editor. Inquiries about missing numbers and other circulation matters should be addressed to the Circulation Manager. Subscription orders for institutions should be sent to the Business Manager. Subscription rate for non-members of ASB is $25.00 per year. Printing and typography by Allen Press, Inc., Lawrence, Kansas 66044. Second class postage paid at Philadelphia, PA and additional mailing office.

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The ASB encourages, in the broadest and most liberal sense, the advancement of biology as a science by: the promotion of research, the increase and diffusion of knowledge of biology, emphasis of the relationship of fundamental knowledge of biology to the solution of biological problems, the preservation of biological resources, and by its meetings, reports, discussions, and publications to promote scientific interests and inquiry, thereby adding to the health, happiness, and knowledge of all peoples. The Association meets annually on campuses of universities and colleges located throughout the southeast. Affiliated organizations meeting with the Association are: Southern Appalachian Botanical Club, Southeastern Section of the Botanical Society of America, Southeastern Region of Beta Beta Beta, South Atlantic Chapter of the Society of Wetlands Scientists, Southeastern Chapter of the Ecological Society of America, Southeastern Division of the American Society of Ichthyologists and Herpetologists, Southeastern Fishes Council, and Southeastern Society of Parasitologists. The ASB has representation in Section G Committee of the AAAS. Varying types of membership are available to individuals and institutions. Members receive the Bulletin.

TIME AND PLACE OF FUTURE MEETINGS

1988	April 13–16	Co-Hosts: University of Southern Mississippi and Gulf Coast Research Laboratory, Biloxi, MS
1989	April 5–8	University of North Carolina–Charlotte, NC
1990	April 19–21	Towson State University, Towson, MD

PATRON MEMBERS

Carolina Biological Supply Co., Burlington, NC
Martin Microscope Co., Easley, SC

ASB ENRICHMENT FUND

The Enrichment Fund Board of Trustees is planning to activate the Enrichment Fund. Further information will be presented in the April issue of the ASB Bulletin.

The Enrichment Fund was established to enhance the educational programs of the ASB. This includes a variety of activities such as awards for research, teaching, and meritorious papers presented at the Annual Meeting; travel awards to assist graduate students with expenses at the Annual Meeting; scholarship awards to graduate and/or undergraduate students; a biology lecture series; and other educational activities.

Contributions to the ASB Enrichment Fund will be received in three categories as follows:

A. General Fund (contributions and annual earned income to meet educational objectives);
B. Restricted Funds (to meet specific educational objectives for one or more years); and
C. Endowments (to provide long-term support to meet specific educational objectives and activities, with only the annual earnings of each endowment expended to meet the objectives for which each was established. Named endowments may be established in honor, or in memory, of a distinguished colleague or family member.)

The Enrichment Fund will provide additional resources and flexibility, enabling the ASB to expand its efforts to promote educational development, teaching, and research. The ASB's accomplishments during its first fifty years were exemplary. Inspired by that progress, we have an excellent opportunity to enrich ASB's educational programs significantly during the second fifty years. The Enrichment Fund will assist us in this endeavor.

Members of the Enrichment Fund Board of Trustees are: Drs. William C. Grant (Chair), Steve C. Dial, James F. Matthews, Grover C. Miller, Sharon Patton, and Robert L. Beckmann (Ex officio).

ASB PRE-REGISTRATION FORM

GULF COAST RESEARCH LABORATORY
AND
UNIVERSITY OF SOUTHERN MISSISSIPPI

(Type or print; one form for each registrant, please duplicate as needed)

NAME____

DEPARTMENT__________________ SCHOOL__________________

CITY__________________ STATE______ ZIP CODE________ PHONE____ ________

If you have made housing reservations, please provide below the name of the hotel, motel, or housing address for the meeting directory.

____

Pre-Registration (deadline will be 1 April)

Regular $18.00 _____ Student $10.00 _____

(Registration at the meeting will be: Regular $25.00; Student $15.00)

ASB SOCIAL HOUR & BANQUET-		
Regular	$15.00	_____
Student	$10.00	_____
SEAFOOD BUFFET at Point Cadet Plaza/ Seafood Museum (please pre-register)	$13.00	_____

BREAKFASTS

ASB Past Presidents	$6.15	_____
Southern Appalachian Botanical Club/SE Section, Botanical Society of America	$6.15	_____

LUNCHEONS

Society of Wetland Scientists	$10.50	_____
BETA BETA BETA	$9.25	_____
SE Chapter, Ecological Society of America	$6.80	_____

FIELD TRIPS

please pre-register by checking line or paying fee

No. 1	Wednesday	No Charge (Make reservations with Dr. Luvall)	
No. 2	Wednesday	$5.00	______
No. 3	Wednesday	No Charge	______
No. 3	Saturday	No Charge	______
No. 4	Wednesday	$5.00 (No pre-payment required)	______
No. 4	Saturday	$5.00 (No pre-payment required)	______
No. 5	Saturday	No Charge	______
No. 6	Saturday	No Charge	______
No. 7	Saturday	$2.50	______
No. 8	Saturday	cost to be determined	______

Total Amount Enclosed: __________

Make checks for total amount payable to ASB Local Committee. Send a completed copy of form and your check by April 1st to:

Gulf Coast Research Laboratory
c/o Thomas D. McIlwain, ASB
P.O. Box 7000
Ocean Springs, MS
39564-7000

NEWS

ABOUT THE MISSISSIPPI GULF COAST MEETING

The Gulf Coast Research Laboratory and the University of Southern Mississippi will host the 49th Annual Meeting of the Association of Southeastern Biologists on 13–16 April 1988 at the Biloxi Hilton Hotel, East Beach, Biloxi, Mississippi. Registration, paper and poster sessions, exhibits, placement services, and the general session will all be at the Biloxi Hilton. Also scheduled are a social hour on Wednesday at the hotel, a seafood buffet dinner on Thursday evening at Biloxi's Point Cadet Plaza, and the traditional Friday evening banquet at the Biloxi Hilton.

SOCIETIES MEETING WITH ASB ON THE MISSISSIPPI GULF COAST

American Society of Ichthyologists and Herpetologists, Southeastern Division
Beta Beta Beta
Botanical Society of America, Southeastern Section
Ecological Society of America, Southeastern Chapter
Society of Wetlands Scientists, South Atlantic Chapter
Society of Wetlands Scientists, South Central Chapter
Southeastern Fishes Council
Southern Appalachian Botanical Club

MISSISSIPPI GULF COAST, GULF COAST RESEARCH LABORATORY AND UNIVERSITY OF SOUTHERN MISSISSIPPI

Please join us for the 49th Annual Meeting of ASB. Located 80 miles west of New Orleans and 60 miles east of Mobile, the Mississippi Gulf Coast borders 70 miles of sandy beaches and productive marshland overlooking the Gulf of Mexico. The area offers numerous recreational opportunities covering a wide variety of interests, including: sport fishing, boating, gourmet dining, specialty shops, swimming, beachcombing, tours of historic antebellum homes, golf (13 different courses), tennis, and nature hikes.

The **Biloxi Hilton Hotel** will serve as headquarters for the ASB meeting. This modern hotel offers excellent convention facilities including 450 guest rooms, various dining facilities, and meeting rooms, as well as recreational facilities including swimming pools and tennis courts.

The **Gulf Coast Research Laboratory**, founded in 1947 by the Mississippi Academy of Sciences, was made an institution of higher learning of the state and a teaching affiliate of the state-supported colleges and universities by an act of the state legislature. The three primary missions of the laboratory are research, education, and service, primarily in the marine sciences. Today the laboratory has a staff of approximately 140 personnel and is affiliated with over 50 colleges and universities. The laboratory staff conducts year-round research in the marine sciences and conducts a fully accredited summer school each year. The main campus is located in Ocean Springs, and the Point Cadet campus, containing the J. L. Scott Marine Education Center, is located in east Biloxi.

The **University of Southern Mississippi**, founded in 1910, has an enrollment of approximately 12,000 students and is one of the three major universities in Mississippi. It is located in the south-central part of the state in Hattiesburg, Mississippi, a prosperous residential community of about 50,000 people which functions as an educational, medical, and commercial center for south Mississippi. The university's instructional programs are administered through 12 colleges and schools. Master's degrees are awarded in 64 fields and doctoral degrees in 17.

The Biological Sciences Department has a faculty of 22 professors and 12 adjunct professors. Master's and doctoral degrees are offered with emphasis areas in botany, environmental biology, genetics, marine biology, microbiology, molecular biology, and zoology. The Department has a strong overall emphasis in aquatic biology.

PRE-REGISTRATION AND REGISTRATION

A PRE-REGISTRATION form is provided with this copy of the bulletin. Your pre-registration will enable us to plan facilities and services to be expected at the ASB meeting. Pre-registration packets and late registration will be at the Biloxi Hilton Hotel on Wednesday from noon to 10:00 P.M. and on Thursday and Friday (see general schedule). Early pre-registration will not only aid us, but will assure your reservation for field trips, special meals, and social events. Only a limited number of tickets for special events will be available at the registration desk.

Please bring your April, 1988 ASB Bulletin to the meeting. Copies of the April Bulletin will be sold at the registration desk for $3.00 each.

TRAVEL TO THE MISSISSIPPI GULF COAST

Automobile: Interstate 10 provides easy access to the Mississippi Gulf Coast and Biloxi from east and west bound origins. From the north, Interstates 55 and 59 and highway 49 are the main routes to the Coast. The meeting site in Biloxi is adjacent to the Gulf on highway 90.

Bus Service: Biloxi is served by Greyhound. The bus terminal is located downtown and is a short taxi ride to the hotel.

Air Service: The Mississippi Gulf Coast is served by Northwest Airlines, Eastern Metro Express, and Continental Express Airlines through the Biloxi/Gulfport Regional Airport. The airport is located approximately 10 miles from the Biloxi Hilton Hotel. Transportation from the airport is available by taxi, limousine service, and rental cars. In addition, Biloxi is only 70 miles west of the New Orleans International Airport which is serviced by 23 airlines. The Mississippi Coast Limousine Service (1-800-647-3957) offers transportation from New Orleans Airport directly to the Biloxi Hilton at a special round-trip convention rate of $40 per person. The convention rate does not apply to one-way service which costs $29. Limousine service requires advance calling to give name and flight number. Be sure to identify yourself as an ASB participant to get the convention rate. The local committee is working to obtain special convention rates from several of the airlines. Such rates, if obtained, will be announced by a mailout from the local committee.

Parking: Ample parking facilities are provided by the Biloxi Hilton Hotel. No special permits are required.

ACCOMMODATIONS

Housing will be available at the Biloxi Hilton Hotel, which is offering special convention rates, and a combination of housing arrangements. Please note that there is no charge for children, *regardless of age,* when they occupy the same room as their parents. Besides conventional rooms, the Hilton offers condominium style rooms for an additional $20. These provide full kitchen facilities, a dining area and a parlor with a pull-out sofa. The condominium option is available with either single or double adjoining rooms. Utensils are available for a nominal additional cost. Rooms are also available in the Tennis Pavilion area. These are essentially motel-like rooms surrounding the tennis courts. The Tennis Pavilion rooms are being offered at a special rate to students; these rooms are also available at the regular convention rate to other participants.

Please make reservations directly with the Hilton. To receive the special room rates be sure to identify yourself as an ASB participant and whether you qualify for student rates.

Biloxi Hilton Hotel
Meeting Headquarters
3580 West Beach Blvd.
Biloxi, MS 39531
(601) 388-7000

S: $50.00 (+$20 w/condo parlor)
D: $56.00 (+$20 w/condo parlor)
Tennis Pavilion facilities
student rates:
S: $40.00
D: $46.00

There are numerous other hotels and motels in the area that are within walking distance. Please check with them directly for reservations and rates.

Biloxi (all hotels listed are within walking distance of the Hilton)

Biloxi Beach Motor Inn
4650 W. Beach Blvd.
outside MS 1-800-345-1570
MS only 1-800-654-1483

Quality Inn Emerald Beach
3251 W. Beach Blvd.
(601) 388-3212

Howard Johnson's
3920 W. Beach Blvd.
(601) 385-5555

Best Western–Biloxi Inn
3910 W. Beach Blvd.
1-800-528-1234

Holiday Inn Coliseum
3890 W. Beach Blvd.
1-800-HOLIDAY

Broadwater Beach Hotel
3600 W. Beach Blvd.
outside MS 1-800-647-3964
MS only 1-800-221-2816

Biloxi Travel Lodge
3650 W. Beach Blvd.
1-800-255-3050

Royal d'Iberville Hotel
3420 W. Beach Blvd.
outside MS 1-800-647-3955
MS only 1-800-222-3906

Biloxi Beach Ramada Inn
3250 W. Beach Blvd.
outside MS 1-800-722-7339
MS only 1-800-331-2241

Beachwater Inn
2872 W. Beach Blvd.
(601) 432-1984

Ocean Springs

Gulf Coast Research Laboratory Dormitory
703 E. Beach Dr.
(601) 875-2244 ext. 201

Dormitory facilities will be available on a first-come basis to *students* only. Please call GCRL directly for reservations. Rates for students from GCRL affiliates = $6.00; rates for students from non-GCRL affiliates = $12.00. A shuttle service will be provided to the Hilton.

CAMPING FACILITIES

Biloxi

Oasis Campground
3240 West Beach Blvd.
Ocean Springs
(601) 388-5590

Gulf Islands National Seashore
3500 Park Road
(601) 875-9057

Send requests for a more detailed listing of accommodations to: Harrison County Tourism Commission, P.O. Box 6128, Gulfport, MS 39506.

GENERAL SCHEDULE

ALL EVENTS AT THE BILOXI HILTON EXCEPT WHERE NOTED

WEDNESDAY, 13 APRIL

Registration: 12:00–10:00 P.M.
Field Trips: 1:00–6:00 P.M., See description of Field Trips and Pre-registration form.
Symposium—Plant and Animal Tissue Culture Update and Teaching of Undergraduates. Sponsored by the SE Section, Botanical Society of America. Presented by Drs. J. Ault and E. Aedes 6:30–8:30 P.M.
ASB Executive Committee Meeting: 2:00–6:00 P.M.
Continuation of ASB Executive Committee Meeting (if needed): 8:00–10:00 P.M.
Social Hour: (Cash Bar) 7:00–10:00 P.M.

THURSDAY, 14 APRIL

Past Presidents' Breakfast: 7:00–8:00 A.M.
Registration: 8:00 A.M.–5:00 P.M.
Exhibits: 8:00 A.M.–5:00 P.M.
General Plenary Session: 8:30–9:45 A.M.
Welcome by *Gerald Blessey*, Mayor of Biloxi
Announcements by the Local Committee
Featured Address by *Dr. Wyatt Anderson*, University of Georgia, General Title: Genetic Engineering: Evolutionary and Ecological Implications.
Paper and Poster Sessions, Placement Service: 8:00 A.M.–5:00 P.M.

Business Meeting: American Society of Ichthyologists and Herpetologists, Southeastern Division, 4:15–5:15 P.M.
Luncheon Meeting: Society of Wetland Scientists, 12:15–1:15 P.M.
Symposium—Biotic Communities of the Southeastern United States—Terrestrial Communities. Sponsored by the SE Chapter of the Ecological Society of America. Organized by *Dr. Ross Hinkle,* 1:30–4:15 P.M.
ASB Reception at Seafood Museum and Seafood Festival Buffet at Point Cadet Plaza: 6:00 P.M.

FRIDAY, 15 APRIL

Registration: 8:00 A.M.–12:00 P.M.
Breakfast and Business Meeting: Southern Appalachian Botanical Club and Southeastern Section, Botanical Society of America, 7:00–8:00 A.M.
Exhibits: 8:00 A.M.–2:00 P.M.
Paper and Poster Sessions, Placement Service: 8:00 A.M.–5:00 P.M.
Symposium—Biotic Communities of the Southeastern United States—Aquatic Communities. Sponsored by the SE Chapter of the Ecological Society of America. Organized by *Dr. Ross Hinkle,* 8:30 A.M.–12:00 P.M.
Business Meetings: Association of Southeastern Biologists, 11:45 A.M.–12:45 P.M.
  Southeastern Fishes Council, 4:00–5:15 P.M.
  Southeastern Division, Ecological Society of America, 4:00–5:15 P.M.
Luncheon Meetings: Tri-Beta, 12:00–1:30 P.M.
  Southeast Chapter, Ecological Society of America, 12:30–1:30 P.M.
Social Hour (Cash Bar): 6:15–7:30 P.M.
ASB Banquet: Grand Ballroom, 7:30 P.M.

SATURDAY, 16 APRIL

ASB Executive Committee Meeting and Breakfast: 8:00 A.M.
Field Trips: Begin at 8:00 A.M., Departures from Biloxi Hilton

POINTS OF INTEREST IN THE GULF COAST AREA

BEAUVOIR—The Jefferson Davis Shrine. The historic last home of Jefferson Davis, only president of the Confederate States of America. Located on U.S. 90 near the coliseum, the landmark features a Davis family museum, Beauvoir cemetery and Tomb of the Unknown Confederate Soldier, gardens, and nature trails. Open from 8:30 A.M. to 5:00 P.M. daily. Adults, $3.75; senior citizens and active military, $3.00; children 13–18, $1.75; children 7–12, $1.25 and children under seven, free.

BILOXI EXCURSION BOAT TO SHIP ISLAND—Ship Island is part of the Gulf Islands National Seashore. The "Pan American" departs from dock at the Pier Restaurant located four blocks east of Biloxi Lighthouse on Hwy. 90. The vessel docks at Ship Island adjacent to historic Fort Massachusetts. Admission: Adults $10.00, Children 3–10, $4.00, children under 3 free. Spring Schedule: Weekdays—departs from Biloxi 2:30 P.M., arrives back in Biloxi at 6:45 P.M. Weekends—departs from Biloxi 9:00 A.M. and 2:30 P.M., arrives back in Biloxi at 1:45 P.M. and 6:45 P.M. Call (601) 432-2197 or 435-1370 for reservations. Well worth it!

BILOXI LIGHTHOUSE—Cast-iron structure 65-feet tall that was built in 1948. Has permanent exhibit of its history in base. Located at U.S. 90 and Porter Avenue, the structure is open Friday through Monday from 10:00 A.M. to 5:00 P.M. and Sunday from 1:00 to 5:00 P.M. Admission is $0.50.

FORT MASSACHUSETTS—This scenic fort was built in 1858. Captured by Union forces early in the Civil War, the fort served as a vital link in the blockage of the South. Located on Ship Island, 12 miles out in the Gulf of Mexico and operated by the National Park Service (601) 875-9057; take the Biloxi Excursion boat to Ship Island (see above). Open year round. No admission charge.

FRIENDSHIP OAK—Gulf Park Campus of USM, Long Beach. The large massive live-oak tree, hundreds of years old, near Hardy Hall dormitory on the campus is enveloped at its trunk by a platform built for lectures and outdoor classes. No admission fee.

GRASSLAWN—U.S. 90, Gulfport. Built in 1836, this southern summer home features 10-foot wide galleries supported by two-story box columns. Hours from 10:00 A.M. to 4:00 P.M. Monday, Wednesday, and Friday, other days by appointment.

GULF ISLANDS NATIONAL SEASHORE—Mainland headquarters located at 3500 Park Road, Ocean Springs. (601) 875-9057. Visitor center features audio-visual programs and exhibits on park resources. Nature trails, camping, wilderness camping, wilderness islands and beaches, historical fort, jon boat marsh tours. No admission charge.

J. L. SCOTT MARINE EDUCATION CENTER AND AQUARIUM—Point Cadet, Biloxi. Features living displays of coastal zone animals including fishes, reptiles, amphibians, and invertebrates. Marine and wildlife films shown every half hour. Operates Monday through Saturday from 9:00 A.M. to 4:00 P.M. Admission free with conference badge.

MAGNOLIA HOTEL—The only remaining pre-Civil War hotel on the Mississippi Gulf Coast. Rue Magnolia, Biloxi. (601) 435-6294. Year round, no admission charge.

MARINE LIFE OCEANARIUM—Gulfport. Trained dolphins and sea lion shows, and giant reef tank. Visitors can view underwater dive shows and feed sea lions and dolphins. Shows from 9:00 A.M. to 6:00 P.M. Adults, $7.50; children 3–11, $5.00, under three, free.

NATIONAL SPACE TECHNOLOGY LABORATORY—Space shuttle test complex where the shuttle's main engines are tested. Indoor and outdoor exhibits following theme of Space-Ocean-Earth. NSTL, Mississippi, located near Bay St. Louis. (601) 688-2321 or 688-2370. Hours: daily 9:00 A.M.–5:00 P.M. No admission charge.

SEAFOOD INDUSTRY MUSEUM—Point Cadet Plaza, Hwy. 90 and First Street, Biloxi. (601) 435-6320. Exhibits depicting the growth and development of the Gulf Coast's colorful seafood industry. Hours: Tuesday–Saturday 9:00 A.M.–5:00 P.M., Sunday 1:00–5:00 P.M. Admission: Adults $2.00, Senior Adults 65 and over $1.00, Students (6–16) $1.00, groups with reservations $0.50 each, under six free.

SHEARWATER POTTERY—Workshop where pottery is made by James Anderson, son of Shearwater Pottery founder Peter Anderson. Founded in 1928, work done by Peter, Walter, and James McConnell Anderson is featured in the showroom. Walter Anderson Cottage open Thursday 1:00–4:00 P.M. or by appointment. 102 Shearwater Drive, Ocean Springs. Hours: Monday 9:00 A.M.–5:30 P.M., Sunday 1:00–5:30 P.M. No admission charge.

TULLIS-TOLEDANO MANOR—Built in 1856 by Christoval Toledano, a New Orleans cotton broker. One of the Coast's most gracious antebellum homes. 947 E. Beach Blvd., Biloxi. (601) 432-2563.

MUSEUMS

GULF COAST RESEARCH LABORATORY RESEARCH MUSEUM—Scientists wishing use of the ichthyological collection should make arrangements in advance by contacting Dr. Stuart G. Poss at (601) 872-4238.

FIELD TRIPS

1. Remote Sensing Workshop (Wednesday, 13 April, 1:00–6:00 P.M.)—The workshop is limited to 12–15 persons and will provide hands-on experience with image processing, data manipulation, etc. Conducted by *Dr. Jeff Luvall* of NASA's Earth Resources Laboratory, National Space Technologies Laboratory, MS 39529. Please sign up for the workshop by 1 April by writing or calling Dr. Luvall (601 688-1916). A bus will leave the Biloxi Hilton at approximately 1 P.M. and will return by 5:30–6:00 P.M. For those wishing to visit NSTL and the Earth Resources Laboratory on their own the visitor center is open everyday 9–5.
2. Coastal Vegetation (Wednesday, 13 April, 1:00–4:00 P.M.)—Several different coastal vegetational habitats will be visited. Tidal marsh vegetation typical of this region will be emphasized. The only naturally occurring sand beach on Mississippi's mainland will be visited. Other areas of interest will include pitcher plant bogs and other wetland habitats along the coast. Tour limited to 20 people. $5.00 charge. Pre-registration and payment must be received no later than 1 April 1988. Led by *Dr. Lionel N. Eleuterius.*
3. J. L. Scott Marine Education Center (Wednesday, 13 April, 2:00–4:00 P.M.; Saturday, 16 April, 9:00–11:00 A.M.)—A guided tour of the 26 aquariums with an explanation of the theme and subthemes relating to the aquatic animals of the area. Also, a behind-the-scenes look at the filtration, lighting, and research capabilities of the Center. No charge. Limited to 25 people each tour.
4. Biloxi Water Front Tour (Wednesday, 13 April, 2:30 P.M.; Saturday, 16 April, 11:00 A.M.—approximate duration of tour—2 hours)—The "Sailfish" will start from the Biloxi Small Craft Harbor and proceed to the vicinity of the new Point Cadet Marina. A trawl will be drawn near the channel, its contents brought on deck and identified by the crew. $5.00 charge (special price to conference attendees). No prepayment required. Unlimited number of people.
5. Bird Watching Tour (Saturday, 16 April, 8:00–11:00 A.M.)—Depending on the availability of migrating birds, the tour will visit the Least Tern Nesting Area in Gulfport, the largest protected area of its kind. Alternatively, the Gulf

Islands National Seashore area will be utilized to observe many of the local water birds. No charge. Tour limited to 20 people. Led by *Judith Toups.*

6. Marsh Tour, Gulf Islands National Seashore (Saturday, 16 April, 9 A.M.)—The tour will include a jon boat tour of the bayous as well as a marsh walk. Sponsored by Gulf Islands National Seashore and the SE Chapter of Ecological Society of America. No charge. Tour limited to 20 people.
7. Crosby Arboretum (Saturday, 16 April, 8 A.M.–noon)—Tour will include walk through the Hillside Bog Natural Area, a large pitcher-plant bog and other natural bog areas. Transportation charge of $2.50. Tour limited to 25. Led by *Chris Wells and Sam Rosso.*
8. Mitigation Wetlands: Success or Failure? You Be the Judge (Saturday, 16 April, 8 A.M.–afternoon)—A tour through natural, constructed, and restored wetland habitats. Nominal cost for lunch and transportation to be determined. Tour limited to 25. Led by *Joanne Brandt and Maggie Shapiro,* US Army Engineer, Mobile District.

Local Arrangements Committee

Co-Chairmen:	Harold Howse	(601) 872-4210
	B. J. Martin	266-4748
Program:	Stephen T. Ross	266-4928
Pre-registration & Registration:	Thomas McIlwain	872-4203
Audio-visual:	Gerald Corcoran	374-5550
Exhibits & Exhibitors:	Stuart Poss	872-4238
Field Trips:	Lionel Eleuterius	872-4251
Social Activities:	Donald Norris	266-4748
Accommodations & Transportation:	Fred Howell	266-4748
Host Facilities:	Gulf Coast Research Laboratory and University of Southern Mississippi P.O. Box 7000 Ocean Springs, MS 39564-7000	872-4200
Meeting Headquarters:	Biloxi Hilton Hotel 3580 West Beach Boulevard Biloxi, MS 39531	388-7000

ASSOCIATION AFFAIRS

GUIDELINES FOR POSTER SESSIONS

Poster sessions have been incorporated as a regular means of scientific presentation at the annual ASB meetings. This type of presentation provides a more informal environment that encourages a direct interchange of ideas and discussion between presenter and audience. Adherence to the following guidelines will help ensure the effectiveness of the poster sessions.

Poster sessions will be held in the Biloxi Hilton Hotel in an area adjacent to the registration desk and exhibits. Consult program for time and location. Posters will be organized by subject matter and numbered sequentially in accord with abstract listings in the ASB Bulletin. All posters will be on display for a half day, although authors or co-authors are required to be with their posters only during a specified session. Thumb tacks and tape will be provided. Backing paper or other special display materials should be supplied by each presenter.

Posters should be carefully planned to maximize clarity and simplicity in conveying information. Poster boards of approximately 4′ by 4′ will be available for each paper. Arrange for a heading including title, author(s) and institution to be placed at the top in letters no less than 3 cm high. The body of the poster should include figures, tables, graphs, maps, or photographs displayed in a well-organized and coherent sequence from top to bottom. Do not crowd the display. All materials including text legends, and captions on figures or tables should be legible from a distance of about 2 m. Each illustration should be captioned. A limited degree of text (letters at least 1 cm high) can be included, but care should be taken not to overwhelm the audience. Authors may choose to post a large typeset copy of the abstract at the top of the poster and include a clear listing of specific conclusions at the bottom.

GUIDELINES FOR RESEARCH AWARDS

ASB Research Awards for Students and Faculty ($500 each). Rules are as follows: (a) Given for especially meritorious paper *presented* by the author(s). Papers must be journal-ready manuscripts worthy of publication. (b) Only ASB members are eligible (this applies to all authors.) (c) Papers may be in press but not published prior to the previous annual meeting. (d) Papers are judged by eminent scientists selected by the committee from institutions outside the southeast. Every effort is made to keep authors of submitted papers anonymous. Criteria for the awards are left to the discretion of the judges who may withhold the award or split the award in case of a tie. (e) Papers must be submitted in *triplicate* and in their entirety. (f) Winners will be announced at the annual banquet. The student award is given to the senior author if he/she is a student at the time of presentation. (g) Send to (*faculty*): Dr. H. R. Delcourt, Department of Botany, University of Tennessee, Knoxville, TN 37915 (phone: 615/974-3094); (*student*): Dr. F. R. Hunter, Department of Biology, Savannah State College, Savannah, GA 31404 (phone: 912/356-2250). The original copy will be sent to the sponsor, and the abstract with an announcement will be in the July ASB Bulletin.

The Eugene P. Odum Award—$100 and a plaque given by the Southeastern Chapter of the Ecological Society of America, for the best ecological paper presented by a student.

The paper will be evaluated by a panel of judges at the time of presentation on the following points: (a) Significance of Ideas; (b) Creativity; (c) Quality of Methodology; (d) Validity of Results; (e) Clarity of Presentation.
Eligibility Requirements:

(a) Undergraduate and graduate students are eligible;
(b) The student must be the sole or senior author;
(c) The paper must deal with a clearly ecological topic and should be presented in any of the following sessions: Aquatic Ecology, Plant Ecology, or Animal Ecology;
(d) The paper must be presented in a regular contributed session; papers presented in poster sessions or symposia are ineligible;
(e) The student does not have to be a member of SE/ESA;
(f) The title and abstract of the paper must be submitted to the Award Coordinator by 1 February. This can be a copy of the abstract submitted to ASB 1 December. Submit to Dr. Steven T. Ross, Department of Biological Sciences, University of Southern Mississippi, Hattiesburg, MS 39406 (phone: 601/266-4928).

The North Carolina Botanical Garden Award—$100 given by NCBG (through the Southeastern Section of the Botanical Society of America and the Southern Appalachian Botanical Club). This is given for an especially meritorious paper presented in the areas of plant systematics, evolution, or conservation. The paper will be evaluated by a panel of judges at the time of presentation, on the following points: (a) significance of ideas, (b) creativity, (c) quality of methodology, (d) validity of results, and (e) clarity of presentation. The actual prize will be presented at the ASB Banquet.
Eligibility Requirements:

(a) All individuals eligible to present a paper at the ASB meetings are eligible for this award.
(b) The paper must deal with the systematics, evolution, species biology (including population biology), or conservation of vascular plants that are native or naturalized to the southeastern United States.
(c) The paper must be presented in a regular Plant Systematics contributed-paper session; papers presented in poster sessions or in symposia are not eligible.
(d) The title and abstract of the paper must be submitted to the Award Coordinator by 1 February 1987. This may be a copy of the abstract submitted to ASB 1 November. Individuals interested in entering a paper for this award should submit the title and abstract to: Dr. George Ramseur, Department of Biology, University of the South, Sewanee, TN 37375.

"TRAVEL" SUPPORT AWARDS FOR GRADUATE STUDENT MEMBERS OF ASB—*DEADLINE: 1 February.* Limited funds are available to partially defray the expenses of graduate students attending the Annual Meeting. The awards are for lodging and meals only. Departments are urged to provide transportation for their graduate students. Recipients must be members of ASB. Preference will be given to those students giving a paper or poster at the Annual Meeting. The guidelines for application are as follows:

1. Give information as to whether you submitted a title and abstract for a paper or poster.
2. Give a conservative, itemized estimate of meeting expenses excluding transportation.
3. In a paragraph, give a brief history of your education to date; indicate how many years you have been, and expect to be, in graduate school, your major field of interest, publications which have appeared or are in preparation, degree sought, name of major professor, and any other pertinent professional details.
4. Give your source(s) of support while in graduate school; *e.g.* NSF, NIH, USDA, Teaching Asst., Research Asst., etc.
5. Have your major professor or department head provide a letter supporting your application, and enclose this letter with your application.
6. Send application, with supporting letter, *all in triplicate,* to: Dr. K. W. McLeod, Savannah River Ecology Lab, Drawer E, Aiken, SC 29802 (phone: 803/450-2472).
7. Applicants will be notified of the decision of the Committee as soon as possible. Recipients of the award will receive their checks at the time of registration at the meeting.

Environmental Education

Consensus among persons attending the Environmental Education Symposium (sponsored by the Southeastern Section of the Botanical Society of America) was that outdoor education no longer occupies an integral part of biology curricula. Many of us who attended are persuaded that more field-oriented educational activities are critical, at the introductory level, if we are to instill environmental understanding in our students, should they have the desire to work against worldwide environmental degradation and destruction. I suggest that southeastern biologists share their ideas, current activities, problems, etc. relating to outdoor education through a column, "Environmental Education," to appear in each issue of the *ASB Bulletin.* Such communications may encourage each other to incorporate more field oriented activities into their courses. Suggestions are welcome: Janice Coffey Swab, Department of Science, St. Mary's College, Raleigh, NC 27603.

NEWS OF BIOLOGY IN THE SOUTHEAST

Jon R. Fortman—*News Editor*
Division of Science and Mathematics
Mississippi University for Women
Columbus, Mississippi 39701

ABOUT PEOPLE AND PLACES

Alabama

Tuskegee University, Department of Biology. Dr. Walter A. Hill and *Dr. J. H. M. Henderson* spent six months at the International Institute for Tropical Agriculture in Ibadan, Nigeria where each worked in their area of expertise, gave seminars, and visited other research centers in the country.

The University of Alabama, Department of Biology. The department has received one of 20 National Science Foundation Biological Centers Program grants to establish a Freshwater Biology Center. The Center, under the direction of *Dr. Amelia K. Ward,* also includes five other members of the department's Aquatic Biology Program, as well as faculty from the departments of Geology and Geography.

Florida

The University of Florida, Department of Botany. James W. Kimbrough has been elected to the Board of Trustees, Highlands Biological Station.

Archbold Biological Station, Lake Placid. Mike McMillian resigned to take a job with the U.S. Forest Service. The Station was host to the Sixth Symposium on African Amphibians sponsored by the University of Miami. About 30 herpetologists attended from all over the USA, Canada, Costa Rica, Argentina, England, Switzerland, Netherlands, and South Africa.

Georgia

Georgia Southwestern College, Department of Biology. Dr. Bob Herrington has joined the department as Assistant Professor of Biology.

Agnes Scott College, Department of Biology. John F. Pilger has been named as Chair of the Department of Biology. He replaces *Sandra T. Bowden* who has served as Chair for eight years.

University of Georgia Institute of Ecology, Savannah River Ecology Laboratory. Kim T. Scribner recently received an award for Most Outstanding Accomplishments in South Carolina Wildlife Research. *Dr. Gary R. Hepp* was appointed adjunct Assistant Professor at the School of Forest Resources. *Dr. Rebecca R. Sharitz* has been appointed editor-in-chief of a new international wetlands journal *Wetlands Ecology and Management,* published by SPB Publishers in the Netherlands. *Dr. Richard A. Seigel* has published a book titled "Snakes: Ecology and Evolutionary Biology" released by Macmillan Publishing Co. His co-editors are *Joseph T. Collins* of the University of Kansas and *Susan S. Novak,* former SREL technical writer. *Dr. Kenneth W. McLeod* was appointed an Adjunct Associate Professor at the School of Forest Resources. *Dr. Domy C. Adriano* was appointed coordinating editor of a new book series published by Springer-Verlag, Inc. The series, yet to be named, will consist of expert reviews of research in environmental science. The first of the series will be published in 1988.

Georgia College, Department of Biological and Environmental Science. Dr. Harold Reed has been appointed as Assistant Professor of Biology. He formerly taught at the Indiana University at Kohomo. His Ph.D. is from Ohio University.

Illinois

Southern Illinois University at Carbondale, Department of Botany. A course entitled "Field Ecology Studies in the Northern Rocky Mountains" will be taught during the summer of 1988 for 6½ weeks.

The base of operation will be the YBRA Field Camp located at the foot of the Beartooth Mountain near Red Lodge, Montana. Students will study ecological characteristics of shrub-desert grassland, coniferous forest, and alpine tundra ecosystems. For exact dates, cost and more information contact: *Dr. P. A. Robertson,* Department of Botany, Southern Illinois Univ., Carbondale, IL 62901 (618/536-2331) by 15 March 1988.

Kentucky

Murray State University, College of Science. The College of Science has recently received funding for the development of a Center for Reservoir Ecosystems Research. The Center will utilize faculty and resources from many areas and sources to conduct ecological studies on Barkley and Kentucky Lakes, two of the largest reservoirs in the southeastern United States.

Louisiana

Louisiana State University at Shreveport, Department of Biological Sciences. Dr. R. K. Speairs has retired from his position as Chairman and Professor. He has been replaced by *Dr. Dalton Gossett,* formerly Chairman of the Department of Biology and Chemistry at Newberry College.

Louisiana State University, Baton Rouge, Department of Botany. Dr. G. Bruce Williamson was elected Vice President for Education of the Organization for Tropical Studies for the 1987–88 year.

Mississippi

Gulf Coast Research Laboratory, Ocean Springs. Northeastern State University, Tahlequah, OK has become the latest affiliate with the Research Laboratory for the purpose of teaching marine sciences to the University's students. This brings the total affiliates to 59, 45 of which are out-of-state institutions. GCRL provides an excellent academic opportunity to the students of inland universities who are interested in the marine sciences.

Mississippi College, Department of Biological Sciences. Dr. Bill P. Stark was on sabbatical leave during the spring semester of 1987. *Dr. Stark* attended the International Symposium on Stoneflies near Melbourne, Australia, and completed a book being coauthored with *Ken Stewart* of North Texas State University. The book, *Nymphs of North American Stonefly Genera (Plecoptera),* is due late Fall 1987. *Dr. Theodore Snazelle* is serving his second year as president of the American Daffodil Society. *Dr. Snazelle* has recently learned that seedlings of three new varieties of daffodils developed by him will be planted in the National Arboretum in Washington, DC.

Mississippi State University, Department of Biological Sciences. Dr. Wallace J. Dominey has joined the department as Assistant Professor. His Ph.D. is from Cornell University in the field of behavioral ecology and evolutionary biology of fish. *Jerome A. Jackson* was honored in April 1987 as the 7th Annual Clyde E. Connell Lecturer at Valdosta State College. *Dr. Jackson's* lecture was entitled "Endangered birds, endangered forests." *Dr. Jackson* also visited Cuba in his capacity as a Director of the U.S. Section of the International Council for Bird Preservation and as an expert on woodpeckers. While in Cuba, *Dr. Jackson* was awarded a medal by the Cuban government for his international research and conservation efforts.

North Carolina

Wake Forest University, Department of Biology. Dr. Gerald W. Esch, Dean of the Graduate School and Professor of Biology, has been named by Governor Jim Martin to the North Carolina Board of Science and Technology for a term extending to 1990. *Dr. James McDonald,* Professor of Biology and former chairman of the department, died on 1 July 1987, from complications of hepatitis. *Dr. McDonald* was a popular and respected teacher whose specialty was mycology.

North Carolina State University, Department of Botany. Dr. Rebecca S. Boston, a plant molecular biologist, has joined the department as an Assistant Professor. Her major area of research involves the transcription of maize zein genes. *Dr. James E. Mickle,* a paleobotanist, recently joined the department as an Assistant Professor with teaching responsibilities in the Biological Sciences Interdepartmental Program. His area of research involves the ecology and developmental biology of marattialean ferns and pteriodosperms.

Highlands Biological Station, Highlands. Grants-in-aid and scholarships in support of field-oriented research will be available in 1988. Support is available for both graduate and postdoctoral students. A series of summer courses will also be offered. Persons interested in conducting research or taking courses at Highlands can obtain applications by writing the Highlands Biological Station, P.O. Box 580, Highlands, NC 28741, or call 704/526-2602.

South Carolina

Furman University, Department of Biology. Dr. Laura K. Thompson recently joined the faculty from the University of Georgia. Her research and teaching specialties are molecular genetics and plant physiology.

Tennessee

Austin Peay State University, Department of Biology. The University's Center of Excellence for the Study of Field Biology of Land Between the Lakes will sponsor a Symposium on the Natural History of Lower Tennessee and Cumberland River Valleys, 11 and 12 March 1988. The Center invites papers on original research for presentation to the contributed paper session of the Symposium. Submit title of paper, indicating co-authors and institutional affiliations by 15 January 1988 to *Dr. David H. Snyder*, Editor, Department of Biology, Austin Peay State University, Clarksville, TN 37044. Abstracts of the papers are due by 1 March 1988. A registration fee of $20 includes one day's lodging and meals at the Brandon Springs Group Camp LBL, site of the Symposium.

University of Tennessee at Martin, Department of Biological Sciences. The newly renovated Reelfoot Lake Teaching and Research Center was officially dedicated on 27 August 1987. The facility includes a classroom-laboratory and living quarters to accommodate 16 people for short periods. The Teaching and Research Center is available for class field trip groups and research investigators on a first-come-first-serve basis. For more information contact *Andy Sliger* or *Wintfred Smith*, University of Tennessee at Martin, Biology Department, Martin, TN 38238, 901/587-7170. *Dr. Ted James* has accepted an administrative position with the UT–Martin Office of Academic Affairs as Associate Vice Chancellor for Academic Affairs.

Middle Tennessee State University of Murfreesboro, Department of Biology. Dr. Marion Wells has authored a textbook with *Dr. A. E. Woods* and *Dr. L. W. Aurant* titled *Food Composition and Analysis*, Van Nostrand Reinhold Co., NY. *Dr. Clay Chandler* was the recipient of the 1986–87 Outstanding Research Award. *Dr. Chandler* has done extensive field research on planaria and has numerous publications to his credit.

West Virginia

West Virginia University, Department of Biology. Patricia E. Gallagher (Ph.D. University of Tennessee) has joined the department. Her area of expertise is repair of DNA damaged by radiation and chemicals. Also, *Dr. Michael A. Kotarski* (Ph.D. Cornell University) is new to the department. His area of research is the molecular biology of gene activity as it relates to the position of the gene in the genome. Finally, the third new member to the department is *Dr. Keith Garbutt* (Ph.D. University of Wales, Bangor). He did post-doctoral work at the University of Illinois and Harvard University. His area of expertise is population genetics. *Dr. Garbutt* was appointed Visiting Assistant Professor of Plant Population Biology, at the University of Virginia, 1987 Summer School, Mountain Lake Biological Station, Pembroke, Va. *Dr. Ed Keller* spent most of the summer in Washington, DC at Gallaudet University for the Deaf. *Dr. Keller* is working on a NSF project concerning the modification and optimization of life science microcomputer software for deaf and hard-of-hearing students for grade levels 8 through 14.

ABOUT MUSEUMS AND BOTANICAL GARDENS

Florida

Orlando Science Center, Orlando. From 16 January to 13 March 1988 "Salad Dressing Physics" will be exhibited at the Center. The exhibit was developed by the Boston's Children Museum. It gives visitors the opportunity to compare familiar liquids like honey and mineral oil, and learn about density, viscosity, and cohesion.

Kentucky

Museum of History and Science, Louisville. The Museum announced in April that *Tom Louderback* had joined the staff. He assumes the position of controller. A Maryland native, he comes from Welenken, Himmelfarb and Co., a local CPA firm. The Museum nominated local teachers *Pam Boykin* of Johnson Middle School and *Suzanne Fulk* of St. Gabriel's School to the Association of Science Technology Centers' Teacher Honor Roll. They were honored in Washington, DC during National Science Week. Only 46 teachers were selected nationally. The Museum, by popular demand, is now offering science classes for preschoolers (ages 4 and 5). Science topics as diverse as gravity, dinosaurs, and water are conveyed with experiments, songs, and activity. Each section is limited to 10 children. *Mr. Barry Bingham, Sr.* and *Eleanor Bingham Miller* have pledged $250,000 to the Museum. These funds will be used to renovate a building to provide room for an IMAX theater.

Louisiana

Lafayette Natural History Museum, Lafayette. The Sense of Sound is the title of a new exhibit that will run from 25 January to 31 May 1988. Cajun Inventions is the title of an exhibit that will be displayed from 13 June until 31 August 1988. A photographic reverie in the reality of life in Louisiana from World War II and its immediate aftermath will be showing 14 September 1987 through 3 January 1988. The Standard Oil of New Jersey photographic collection is entitled: "Postwar to Prosperity? Louisiana 1946–1950."

Mississippi

The Crosby Arboretum, Picayune. Over 40 biologists from Mississippi and Louisiana met at Pinecote for a morning introduction to the Interpretive Center, a field trip to some of the natural areas, and unhurried luncheon conversation. It was an opportunity for a large number of regional scientists to both meet each other and to evaluate the potential of Arboretum facilities for teaching and research.

South Carolina

Brookgreen Gardens, Murrells Inlet. Marjorie Hozian and *Aurora Olivieri* are new employees at the Gardens. *Ms. Hozian* is in charge of cataloging and organizing the specialized library collections. *Ms. Olivieri* is the Education Coordinator with primary duties of developing and implementing Brookgreen's public and school education programs in natural history, and supervising the Volunteer and Docent Programs.

SPECIAL SYMPOSIUM INFORMATION

Beltsville Symposium XIII: 9–11 May 1988 Beltsville, MD. *Biotic Diversity and Germplasm Preservation—Global Imperatives.* In recognition of accelerating threats to biotic diversity, the symposium will focus on needs and opportunities for preservation and utilization of our natural heritage. Contact either Lloyd Knutson, Biosystematics and Beneficial Insects Institute (301/344-3182) or Allan K. Stoner, Plant Genetics and Germplasm Institute (301/344-3234), Beltsville Agricultural Research Center, Agricultural Research Center, USDA, Beltsville, MD 20705.

REVIEWS

Tiner, Ralph W. 1987. **A Field Guide to Coastal Wetland Plants of the Northeastern United States.** The University of Massachusetts Press, Amherst, MA. $25.00. 285 p.

The stated objective of this book is to provide a field manual to common coastal wetland plants (excluding trees) of the northeast. This manual is geared to the "non-technical person interested in learning to recognize common tidal wetland plants." The manual begins with a brief introduction to coastal wetland ecology, consisting of a short description of six principal types of coastal wetlands. The majority of the book is composed of a series of dichotomous keys, line drawings of representative species, and a short description of each species. Nearly 150 common species are included. Descriptions include plant characters, flowering period, habitat, and range. A state by state listing (including maps) of where coastal wetlands can be observed is also given.

Although the purpose of this manual is identification, the keys falter on their lack of technical language. Couplets are often not mutually exclusive and are confusing. Therefore, much seems to rest on the use of the line drawings. Some of the drawings are nicely done and emphasize important diagnostic characters. However, others are too idealized to be of much help. Coverage of several of the more difficult groups, e.g., *Potamogeton* and *Eleocharis,* is superficial and weak.

This manual represents a reasonable attempt at providing a field guide to coastal wetland plants. For one not provided with any other manual, technical or not, this guide would provide a starting point for identification. The manual will be most useful to amateurs. However, those who deal with more professional aspects of coastal wetland plant identification, e.g., environmental consultants and members of wetland agencies, may find this manual of little value. Its limited usefulness derives from the non-technical approach employed. Other than compiling a list of common coastal wetland species this manual provides little more than is already available in existing works.

C. Thomas Philbrick, *Department of Ecology and Evolutionary Biology, U-43, The University of Connecticut, Storrs, CT 06268.*

Seigel, R. A., J. T. Collins, and *S. S. Novak* (eds.) 1987. **Snakes: Ecology and Evolutionary Biology.** Macmillan Publishing Co., NY. $55.00. 529 p.

As the reader will immediately discern this is not a textbook, but is a series of individually authored chapters on many aspects of snake biology. Three major themes are addressed: Evolutionary Biology and Morphology; Techniques; and Life History and Ecology. As the editors note, the coverage could not be as broad as they had hoped because of the financial realities of publishing—to do real justice to snake biology would require a "Biology of the Serpentes" series. Readers familiar with the extensive and fastidious "Biology of the Reptilia" series can thoroughly appreciate that limited as our knowledge of the herpetofauna may be a coverage of basic topics requires a tremendous number of pages. The present book provides a review of current knowledge, a summary of primary literature, and a focus on areas in which research attention is needed.

Because organic evolution is central to the theme of contrasting patterns of the biology of organisms, the most fundamental need is to understand the systematic relations. The first two chapters: "Systematics" by S. B. McDowell and "Fossil History" by J.-C. Rage are at once disturbing and exciting, because the two authors have different views on snake origin and phylogeny. Rage tells us that the fossil record is based mostly on vertebral form, but that articulated skeletons are rare, and McDowell asserts that closely related forms of living snakes may have quite different vertebrae, and that differences within the column of a single individual may exceed those between corresponding vertebrae of different genera. The first two chapters thus make the reader realize that the evolution of snake classification can be as remarkable as the classifications themselves; new approaches are constantly being employed and intercalated with older ideas. J. E. Cadle, in chapter 3 (Geographic Distribution), largely follows McDowell's version for the sake of uniformity. Most other chapters deal with minor hierarchies, particularly interspecific comparisons, thus the value of those contributions to understanding systematics is minimized.

Certain aspects of McDowell's interpretation create awkward situations. He places Viperidae and Colubridae in "Series Opisthoglypha" (not a formal taxon), a bad name considering the meaning of the word "opisthoglyph." Viperids are noted for their anteriorly located fangs, whereas colubrids have rear fangs. In another non-formal taxon, "Series Proteroglypha," McDowell contrasts Atractaspidae against Elapidae on the basis of vertebrae, which seems awkward considering the importance of the poison apparatus; atractaspids have folding fangs, elapids have fixed fangs. But the phylogeny of the hypothetically ancestral colubrids is complex, as indicated by the contrasting views of herpetologists on the derivation or degeneration of the venom apparatus. As McDowell states, "Cadle's 1982 work shows albumin differences between viperids and colubrids are so great that the descent of viperids from any modern day colubrid lineage is unlikely." Both McDowell's and Rage's presentations could benefit from inclusion of illustrative material to show contrasting morphological variations.

Cadle's chapter on geographic distribution considers molecular data to be the best way to determine relationships, hence probable geographic origins, but he admits that correlation of vertebrae with living faunal lineages is necessary so that the fossil record can be used to analyze past distributions. Cadle thus primarily reviews extant lineages and attends to the fossil record only as it relates to historical biogeographic patterns.

D. Cundall explores locomotor and feeding mechanisms in the final chapter of the first section, with close attention to musculoskeletal relations. It is an excellent review of the remarkable nature of limbless locomotion and the highly specialized jaw mechanisms of snakes.

The second section consists of a chapter on collecting and life history techniques by H. S. Fitch and one on captive maintenance by J. B. Murphy and J. A. Campbell. Much of these chapters is information on well-known methodology but is valuable summaries for those who may be moved by this book to select snakes for their research programs.

In the nine chapters on life history and ecology one underlying problem constantly surfaces, the paucity of knowledge of tropical species in contrast to what we know about temperate forms. The last chapter of the book by C. K. Dodd, on conservation and management, leaves little doubt that extinction of many species in the near future is more likely than our ability to study and solve ecological problems so that the earth can successfully contain both man and much of the world's biota. We may never be able to make enough inroads on the biology of tropical forms to fully understand evolutionary ecology.

The remaining chapters include "Social Behavior" by J. C. Gillingham, which while presenting a good coverage of the topic is less analytical of the implications. R. A. Seigel and N. B. Ford give a good review and analysis of reproductive behavior. "Population Ecology" by W. S. Parker and M. V. Plummer, "Foraging Ecology" by H. R. Mushinsky, "Communities" by L. J. Vitt, "Social Patterns and Movements" by P. T. Gregory, J. M. Macartney, and K. W. Larsen, "Activity Patterns" by J. W. Gibbons and R. D. Semilitsch are excellent reviews and analyses. Physiological ecology is unfortunately poorly represented in the book; a single chapter, "Temperature, Energetics, and Physiological Ecology," by H. B. Lillywhite does justice to the importance of temperature to ectotherm physiology but leaves one wondering if we know so little about the rest of snake physiology or if space constraints give short shrift to other aspects of physiology.

Overall the book is well-done and stimulating. The sequence of chapters is not what I'd like to have seen; perhaps communities followed by population ecology, spatial patterns and movements, then foraging ecology would have improved the reader's understanding. But each chapter does well in providing the essentials of areas to which individual researchers tend to confine themselves. The reader will become highly cognizant of the many fertile areas for exploring ecology by using snakes as his models.

A sharper editorial pen would be advisable; the use of the indefinite "it" is excessive, thus wasting words, and in some places abuse of "data" as if it were singular occurs.

Harold A. Dundee, *Department of Biology, Tulane University, New Orleans, LA 70118.*

Tyler, Varro E. 1987. **The New Honest Herbal, a Sensible Guide to the Use of Herbs and Related Remedies.** George F. Stickley Co., Philadelphia, PA. $18.95. 244 p.

Since the investigation of the drug industry led by Senator Estes Kefauver of Tennessee in 1962, many herbal products that would otherwise be sold in pharmacies as over-the-counter drugs, are now sold in "health food" stores. Marketing of these products represents a multi-million dollar a year industry in this country alone. Thousands of people depend on herbs for self-medication of common ills such as arthritis, colds, constipation, impotence, indigestion, and even hypertension.

Do these so-called remedies actually work? Are there available other products that are more effective or economical? Could they be poisonous, or have serious side-effects?

There is available today a large number of pamphlets as well as more comprehensive volumes, "herbals." These constitute an "advocacy literature" in which traditional (often centuries old) uses of herbs are presented uncritically; modern scientific investigations into their alleged efficacy and potential harm are ignored.

On the contrary, *The New Honest Herbal* takes a basically objective perspective. An alphabetic (Alfalfa to Yucca) treatment of 108 herbal preparations follows two brief introductory chapters; their inclusion reflecting their availability and popularity in retail outlets. A few of the products, honey and royal jelly as examples, are primarily of animal origin.

The pros and cons of each preparation are considered. For example, aloe, the familiar potted windowsill plant, is recognized as an inexpensive and effective remedy for minor burns. But, the reader is warned that, contrary to recommendations of many popular writers, the use of mistletoe tea is very dangerous, because of toxic principles in the berries and leaves.

An especially useful feature of this book is the index which is in the form of a "Summarized Evaluation of Herbal Remedies." By consulting this section, one can see at a glance how each of the 108 products is rated in regards to "apparent efficacy" and "probable safety." For example, the bark of the yohimbe tree, *Pausinystalia yohimbe,* is probably effective as an aphrodisiac; however, there is a question in regard to its safety. Details, of course, are given in the main portion of the book.

Certainly, time-honored remedies are worthy of serious consideration; their chemical composition and physiological action should be determined. Meanwhile, the prudent consumer/patient should take a conservative and cautious approach to self-medication. This is the theme of this book.

Varro Tyler, a highly respected specialist in pharmacognosy and author of a widely used textbook in that field, is currently academic vice-president at Purdue. This herbal, although written for the layman, is scientifically documented. There are no illustrations; the cover is flexible.

A more comprehensive book on this subject, Lewis and Elvin-Lewis (1977), is somewhat dated; the second edition is in preparation but will probably not be available before late 1988. At least until then, the *New Honest Herbal* is probably the best single source of objective herbal information.

Lewis, Walter H. and Memory P. F. Elvin-Lewis. 1977. Medical Botany, Plants Affecting Man's Health. John Wiley and Sons, New York. 515 p.

Thomas E. Hemmerly, *Department of Biology, Middle Tennessee State University, Murfreesboro, TN 37132.*

Lilly, John C. 1987. **Programming and Metaprogramming in the Human Biocomputer. Theory and Experiments.** The Julian Press (Crown Publishers, Inc.), New York, NY. $10.95. 192 p.

This is a reprint of a book which carries the original copyright date of 1967. According to the preface, much of the material was gathered from 1964 through 1966.

During those years, some drug experimentation on the hallucigens on humans was being done by an occasional scientist. The present book is devoted largely to the effects of LSD on the author's mental state. Not unexpectedly the result is subjective, anecdotal, and rambling.

The inner working of the human brain is a fascinating subject, but we suggest that considerably more recent and better-documented scientific reading is available. Also several books on the subject are directed toward the intelligent layman and we find these eminently more readable.

Melba C. Caldwell and David K. Caldwell, *Marineland of Florida, St. Augustine, FL 32086.*

Lilly, John C. 1987. **Communication Between Man and Dolphin. The Possibilities of Talking with Other Species.** The Julian Press, Inc. (Crown Publishers, Inc.), New York, NY. $10.95. 288 p.

This is a reprint of a book published in 1978. Much of the text even then was based upon earlier publications of the author and there is no new material in the book.

The thesis presented by the writer (Introduction) is that those cetaceans such as dolphins which do have brains as large as humans, have equally good problem-solving abilities, superior ethics, and a more complex communication system. This is a rather broad leap in logic and completely unacceptable. Even today, we have very little hard data about what is going on in the dolphin's brain. Conventional wisdom today leans toward the opinion that much of their brain area is devoted to acoustic analysis. The echolocation system and complex social structure both would suggest the need for increased neural tissue.

At any rate, very modest but concrete increases have been made in our knowledge of dolphin thought processes since the material in this book last was promulgated. The 1986 book "Dolphin cognition and behavior: a comparative approach" (Edited by Schusterman, Thomas, and Wood) is an excellent introduction to the most recent work in this area. We recommend it as an excellent starting point for those interested in dolphin "intelligence" and communication.

MELBA C. CALDWELL and DAVID K. CALDWELL, *Marineland of Florida, St. Augustine, FL 32086.*

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The ASB BULLETIN

Volume 35, Number 2

April 1988

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The Official Quarterly Publication of
The Association of Southeastern Biologists

ASB Bulletin

(ISSN 0001-2386)

The ASB Bulletin, established in 1954 as the official quarterly publication of the Association of Southeastern Biologists, a non-profit scientific and educational association, is published in January, April, July, and October at Lawrence, Kansas. All contributions should be sent to the Editor. News items should be sent to the News Editor. Inquiries about missing numbers and other circulation matters should be addressed to the Circulation Manager. Subscription orders for institutions should be sent to the Business Manager. Subscription rate for non-members of ASB is $25.00 per year. Printing and typography by Allen Press, Inc., Lawrence, Kansas 66044. Second class postage paid at Philadelphia, PA and additional mailing office.

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The ASB encourages, in the broadest and most liberal sense, the advancement of biology as a science by: the promotion of research, the increase and diffusion of knowledge of biology, emphasis of the relationship of fundamental knowledge of biology to the solution of biological problems, the preservation of biological resources, and by its meetings, reports, discussions, and publications to promote scientific interests and inquiry, thereby adding to the health, happiness, and knowledge of all peoples. The Association meets annually on campuses of universities and colleges located throughout the southeast. Affiliated organizations meeting with the Association are: Southern Appalachian Botanical Club, Southeastern Section of the Botanical Society of America, Southeastern Region of Beta Beta Beta, South Atlantic Chapter of the Society of Wetlands Scientists, Southeastern Chapter of the Ecological Society of America, Southeastern Division of the American Society of Ichthyologists and Herpetologists, Southeastern Fishes Council, and Southeastern Society of Parasitologists. The ASB has representation in Section G Committee of the AAAS. Varying types of membership are available to individuals and institutions. Members receive the Bulletin.

Time and Place of Future Meetings

1988	April 13–16	Co-Hosts: University of Southern Mississippi and Gulf Coast Research Laboratory, Biloxi, MS
1989	April 5–8	University of North Carolina–Charlotte, NC
1990	April 19–21	Towson State University, Towson, MD

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PROGRAM OF THE 49th ANNUAL MEETING OF THE ASSOCIATION OF SOUTHEASTERN BIOLOGISTS

MISSISSIPPI GULF COAST,
GULF COAST RESEARCH LABORATORY AND
UNIVERSITY OF SOUTHERN MISSISSIPPI

SOCITIES MEETING WITH ASB ON THE MISSISSIPPI GULF COAST

American Society of Ichthyologists and Herpetologists, Southeastern Division
Beta Beta Beta
Botanical Society of America, Southeastern Section
Ecological Society of America, Southeastern Chapter
Society of Wetlands Scientists, South Atlantic Chapter
Society of Wetlands Scientists, South Central Chapter
Southeastern Fishes Council
Southern Appalachian Botanical Club

GENERAL INFORMATION

Registration- Pre-registration packets and late registration will be at the Biloxi Hilton Hotel beginning Wednesday, April 13, from noon to 10:00 P.M., and on Thursday and Friday (see general schedule). Any remaining tickets for field trips, special meals, and social events will also be available at the registration desk. Please bring your April, 1988 **ASB Bulletin** to the meeting. Copies of the April Bulletin will be sold at the registration desk for $3.00 each.

Parking- Ample parking facilities are provided by the Biloxi Hilton Hotel. No special permits are required. Shuttle service from the Gulf Coast Research Laboratory dormitories to the Hilton will be provided, beginning Wednesday afternoon.

Placement Service- Message boards will be available near the registration desk for those wishing to announce available jobs.

Dining and Lounge Facilities- Meals and cocktails are available at the Biloxi Hilton. Numerous dining facilities are located along the Gulf Coast area. A detailed listing of dining facilities is provided in the registration packet.

Wednesday Evening Social- The social will be on the second floor of the Biloxi Hilton, on the Promenade Terrace, beginning at 7 PM.

Thursday Evening Social and Dinner- These events will be at the Point Cadet Plaza area, across from the Gulf Coast Research Laboratory Marine Education Center. Shuttle buses will begin leaving the lobby area of the Hilton at 5:30 PM.

ASB Banquet- The ASB banquet and program will be held at the Biloxi Hilton.

Field Trips- All field trips will depart from the Biloxi Hilton.

Oceanography Building, Gulf Coast Research Laboratory

Administration Building, University of Southern Mississippi

Useful Telephone Numbers (area code 601)-

Harold Howse, Co-Chairman	872-4210
B.J. Martin, Co-Chairman	266-4748
Stephen T. Ross, Program Chair	266-4928
Thomas McIlwain, Registration	872-4203
Biloxi Hilton Hotel, Meeting Headquarters	388-7000

PROGRAM SUMMARY

ALL EVENTS AT THE BILOXI HILTON EXCEPT WHERE NOTED

WEDNESDAY, APRIL 13, 1988

12:00 P.M.- 10:00 P.M.	Registration, Island Bar
1:00 P.M.- 6:00 P.M.	Remote Sensing Workshop at NSTL
1:00 P.M.- 4:30 P.M.	Field Trips: Coastal Vegetation 1-4:00; Marine Education Center 2-4:00; Water Front Tour 2:30-4:30.
2:00 P.M.- 6:00 P.M.	ASB Executive Committee Meeting, Caprice Room
8:00 P.M.- 10:00 P.M.	Continuation of ASB Executive Committee Meeting (if needed), Caprice Room
7:00 P.M.- 10:00 P.M.	Social, Sandpiper Terrace & Promenade (Cash Bar)

PAPER SESSION I

6:30 P.M.- 8:30 P.M.	Symposium: "Plant and Animal Tissue Culture: Update and Teaching of Undergraduates." Ship Isle Room. Sponsored by the SE Section, Botanical Society of America. Organized by Dr. Eloise Carter

THURSDAY, APRIL 14, 1988

7:00 A.M.- 8:00 A.M.	Past President's Breakfast, Caribbean Room
7:00 A.M.- 8:00 A.M.	Council Meeting, Southern Appalachian Botanical Club, Pacific Room
8:00 A.M.- 5:00 P.M.	Registration, Island Bar
8:00 A.M.- 5:00 P.M.	Exhibits, Topaz Room
8:00 A.M.- 5:00 P.M.	Slide Preparation Room, Surf Room

GENERAL PLENARY SESSION

Crystal Room

8:30 A.M.- 9:45 A.M.	Introductory Remarks: Dr. Harold Howse, Co-Chairman, Local Committee Welcome to Biloxi: Mayor Gerald Blessey; Response: Dr. Rebecca Sharitz, ASB President, Savannah River Ecology Laboratory **Featured Address: Genetic Engineering: Ecological and Environmental Implications** **Dr. Wyatt Anderson, University of Georgia.**

PAPER SESSION II

10:00 A.M.- 11:45 P.M.	Animal Physiology, Petis Bois Room
10:00 A.M.- 12:00 P.M.	Cell/Molecular Biology and Genetics, Chandeleur Room
10:00 A.M.- 12:00 P.M.	Ichthyology, Session I, Crystal Room
10:00 A.M.- 11:45 P.M.	Invertebrate Zoology, Ship Isle Room
10:00 A.M.- 12:00 P.M.	Plant Ecology, Session I, Emerald Room
10:00 A.M.- 10:45 P.M.	Teaching, Deer Isle Room

POSTER SESSION I

10:00 A.M.- 5:00 P.M.	Posters on Display, Pre-Assembly Area

BUSINESS AND LUNCHEON MEETINGS

12:15 P.M.- 1:15 P.M.	Society of Wetland Scientists Luncheon, Caprice Room

FIELD TRIPS

12:30 P.M.- 3:30 P.M.	Tri-Beta: Davis Bayou Interpretive Walk

PAPER SESSION III

1:30 P.M.- 4:30 P.M.	Symposium: "Biotic Communities of the Southeastern United States- Terrestrial Communities", Crystal Room. Sponsored by the SE Chapter of the Ecological Society of America. Organized by Dr. Ross Hinkle
1:30 P.M.- 4:00 P.M.	Aquatic Ecology, Session I, Chandeleur Room
1:30 P.M.- 4:15 P.M.	Ichthyology, Session II, Emerald Room
1:30 P.M.- 4:45 P.M.	Plant Ecology, Session II, Ship Isle Room
1:30 P.M.- 3:15 P.M.	Wetlands Ecology and Management, Deer Isle Room

POSTER SESSION I

4:00 P.M.- 5:00 P.M.	Presenters with Posters, Pre-Assembly Area

SPECIAL MEETINGS

4:30 P.M.- 5:30 P.M.	Business Meeting SE Division of ASIH, Emerald Room
6:00 P.M.	RECEPTION AT SEAFOOD MUSEUM AND SEAFOOD FESTIVAL BUFFET AT POINT CADET PLAZA (Transportation Available from Main Lobby Beginning at 5:30)

FRIDAY, APRIL 15, 1988

7:00 A.M.- 8:00 A.M.	Breakfast & Business Meeting, Southern Appalachian Botanical Club and Southeastern Section, Botanical Society of America, Petit Bois Room
8:00 A.M.- 12:00 P.M.	Registration, Island Bar
8:00 A.M.- 2:00 P.M.	Exhibits, Topaz Room
8:00 A.M.- 5:00 P.M.	Slide Preparation Room, Surf Room

PAPER SESSION IV

8:30 A.M.- 11:30 P.M.	Symposium: "Biotic Communities of the Southeastern United States- Aquatic Communities," Crystal Room. Sponsored by the SE Chapter of the Ecological Society of America. Organized by Dr. Ross Hinkle
8:30 A.M.- 12:00 P.M.	Symposium: "Ecology of Mesic Forest Herbs," Chandeleur Room. Organized by Drs. Beverly Collins and Gary Wein
8:30 A.M.- 11:15 P.M.	Animal Ecology, Deer Isle Room
8:30 A.M.- 11:30 P.M.	Herpetology, Ship Isle Room
8:30 A.M.- 12:00 P.M.	Plant Ecology, Session III, Emerald Room
8:30 A.M.- 11:30 P.M.	Plant Systematics, Session I, Caprice Room

POSTER SESSION II

10:00 A.M.- 5:00 P.M.	Posters on Display, Pre-Assembly Area

BUSINESS AND LUNCHEON MEETINGS

12:00 P.M.-	1:15 P.M.	Tri-Beta Luncheon, Grand Casino
12:15 P.M.-	1:15 P.M.	ASB Business Meeting, Crystal Room
12:30 P.M.-	1:30 P.M.	Luncheon, Southeast Chapter, Ecological Society of America, Petit Bois Room

PAPER SESSION V

1:30 P.M.-	5:00 P.M.	Tri-Beta, Crystal Room
1:30 P.M.-	5:00 P.M.	Tri-Beta, Emerald Room
2:00 P.M.-	4:00 P.M.	Aquatic Ecology, Session II, Caprice Room
2:00 P.M.-	4:00 P.M.	Ichthyology, Session III, Ship Isle Room
2:00 P.M.-	2:45 P.M.	Parasitology, Chandeleur Room
2:00 P.M.-	5:00 P.M.	Plant Systematics, Session II, Deer Isle Room

POSTER SESSION II

4:00 P.M.-	5:00 P.M.	Presenters with Posters, Pre-Assembly Area

SPECIAL MEETINGS

4:15 P.M.-	5:30 P.M.	Business Meeting, Southeastern Fishes Council, Ship Isle Room
4:15 P.M.-	5:15 P.M.	Business Meeting, Southeastern Division, Ecological Society of America, Caprice Room
6:15 P.M.-	7:30 P.M.	Social Hour, Boardwalk Cafe (Cash Bar)
7:30 P.M.		ASB Banquet, Grand Ballroom (Topaz and Crystal room)

SATURDAY, APRIL 16, 1987

8:00 A.M.	ASB Executive Committee Meeting and Breakfast, Atlantic Room
8:00 A.M.	FIELD TRIPS. Departures from main lobby, Biloxi Hilton

ASB
PAPER, POSTER AND SYMPOSIUM SESSIONS

WEDNESDAY EVENING, April 13

PAPER SESSION I

SYMPOSIUM: PLANT AND ANIMAL TISSUE CULTURE: UPDATE AND TEACHING OF UNDERGRADUATES

Sponsored by the SE Section, Botanical Society of America.

Ship Isle Room

Presiding: Dr. Eloise Carter, Emory University

6:30 1. Ault, James R. (University of Georgia). Plant propagation, preservation,and breeding throughcelland tissue culture.

7:30 2. Ades, E. W. and V. G. George. (Centers for Disease Control). Mammalian cell lines for biological products.

THURSDAY MORNING, APRIL 14

PLENARY SESSION

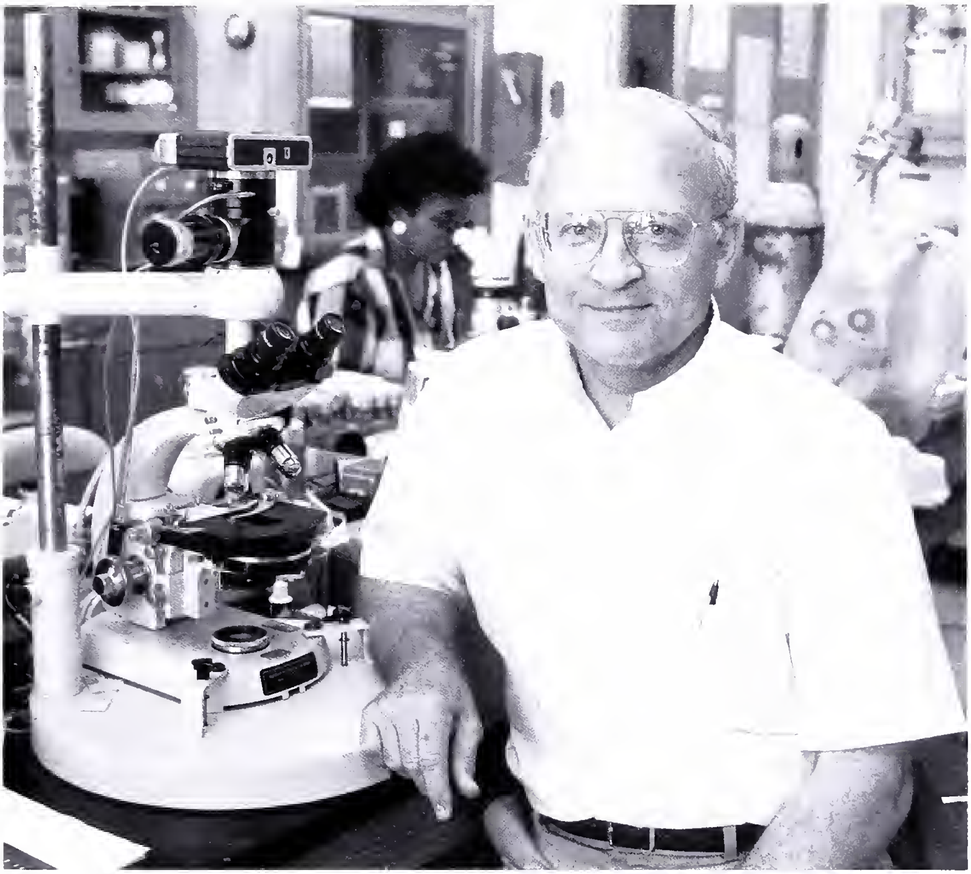
8:30 A.M.

Crystal Room

DR. WYATT ANDERSON

GENETIC ENGINEERING: ECOLOGICAL AND ENVIRONMENTAL IMPLICATIONS

Wyatt W. Anderson is a native southerner who received his B.S. and M.S. in Zoology from the University of Georgia. In 1967 he received his Ph.D. in life sciences from Rockefeller University, under the direction of Theodosius Dobzhansky. He served as Assistant and Associate Professor of Biology at Yale University before returning to Georgia, where he is currently Professor of Genetics. From 1980 until 1987 he was the first head of the newly formed Department of Genetics at the University of Georgia. He is a member of the National Academy of Sciences and a Fellow of the American Association for the Advancement of Science. In 1986 he served as President of the American Genetic Association and in 1987, as President of the American Society of Naturalists. His research has focused on population genetics, and in particular on the mechanisms by which natural selection operates. He is currently using the techniques of molecular biology to explore the evolutionary history of chromosomes in Drosophila.



Dr. Wyatt Anderson, University of Georgia

The development of recombinant DNA technology over the past fifteen years has led to a much deeper understanding of how genes are organized and how they function. The application of these techniques to agriculture and medicine, as well as other fields, has given rise to a flourishing biotechnology industry. Since the beginning of research using recombinant DNA techniques, the scientists most involved with this work have explored concerns about the safety of this new technology. With the commercial application of recombinant DNA techniques in the past few years, questions have been raised about the environmental impact of introducing genetically engineered organisms into the environment. Dr. Anderson will address this issue, drawing on his experience as a member of the committee which drafted the recent report from the National Academy of Sciences, "Introduction of Recombinant DNA-Engineered Organisms into the Environment: Key Issues."

PAPER SESSION II

ANIMAL PHYSIOLOGY, Petit Bois Room

Presiding: Dr. James Larsen, University of Southern Mississippi

10:00 3. Garst, David G. and David R. Hartman. (Western Kentucky University). Some properties of a carboxylesterase from wax moth, *Galleria mellanella* larvae.

10:15 4. Walton, Julie S. and J. B. Claiborne. (Georgia Southern College). Acid-base regulation in teleosts.

10:30 5. Mooney, Richard L. and T. Daniel Kimbrough. (Virginia Commonwealth University). Purification of serotonin-binding proteins from the ileum -anterior colon of the American cockroach.

10:45 6. Kimbrough, T. Daniel and Richard Mooney. (Virginia Commonwealth University). Effects of serotonin S_2-Antagonists Ketanserin and Ritanserin on serotonin-induced myopathies in albino mice.

11:00 7. Zavos, P. M., S. K. Hunt, D. R. Varney, R. W. Hemken and M. R. Siegel. (University of Kentucky). Effects of feeding endophyte-infected tall fescue seed on reproductive performance in male CD-1 mice via competitive breeding.

11:15 8. Wiles, L. A., D. R. Varney, M. R. Siegel and P. M. Zavos. (Eastern Kentucky University and University of Kentucky). Mouse pup growth through weaning as affected by endophyte infected tall fescue.

11:30 9. Varney, D. R., Z. A. Ruhman, R. Stamper, L. P. Bush, M. R. Siegel and P. M. Zavos. (Eastern Kentucky University and University of Kentucky). Growth and reproduction in female rats fed a diet containing a serial extract of endophyte infected tall fescue seed.

CELL/MOLECULAR BIOLOGY and GENETICS, Chandeleur Room

Presiding: Dr. William E. Hawkins, Gulf Coast Research Laboratory

10:00 10. Hamilton, Janet C. and G. S. Trelawny. (James Madison University). Partial purification and characterization of arginase from *Phlyctochytrium semiglobosum*.

10:15 11. Hill, Donna R. and Valgene L. Dunham. (Western Kentucky University). Replicating enzymes in soybean (*Glycine max*) and in healthy and CaMV-infected Turnip (*Brassica rapa*).

10:30 12. Morton, David. (Frostburg State University). Staining and histochemistry of Fe^{+3} positive pigments in the GI tract of an obligate sanguivore, the common vampire bat (*Desmodus rotundus*).

10:45 13. Denniston, Katherine J., Gerard Robey and Daniel K. Haapala. (Towson State University and Abbott Laboratories). Isolation and characterization of an endogenous feline retrovirus with a novel coat protein.

11:00 14. Ramesh, Marilee A. and S. K. Ballal. (Tennessee Technological University). The isolation and culture of Jojoba (Simmondsia chinensis) protoplasts.

11:15 15. Beatty-DeSana, Jeanne and Michael A. Bishop. (Georgia Retardation Center). An unusual inherited fragile site in human chromosomes.

11:30 16. Langevin, Susan A., James B. Grace and Keith Clay. (Louisiana State University and Indiana University). Hybridization between red rice and cultivated rice (Oryza sativa L.).

11:45 17. Keller, Gwen P. (Savannah River Ecology Laboratory). Electrophoretic detection of hybrid tree hoppers (Membracidae) on hybrid oak trees (Quercus).

ICHTHYOLOGY, SESSION I, Crystal Room

Presiding: Dr. Gary Meffe, Savannah River Ecology Laboratory

10:00 18. Howard, James H. and Raymond P. Morgan. (Frostburg State University and Appalachian Environmental Laboratory, University of Maryland). Genetic evidence for stream capture in the central Appalachians.

10:15 19. Mayden, Richard L. and Ronald H. Matson. (University of Alabama, Tuscaloosa). Preliminary analysis of systematic placement of Notropis rubellus (Cyprinidae).

10:30 20. Grady, James M., James S. Rodgers and R. C. Cashner. (University of New Orleans). Evolutionary and biogeographic relationships of Fundulus catenatus.

10:45 21. Brenneman, William M. and John V. Conner. (University of Southern Mississippi and Gulf States Utilities Company). Assoc--iation of lower Mississippi River environments based on relative abundance of fish life history stages.

11:00 22. Hunt, Todd D. (Tennessee Cooperative Fisheries Unit, Tennessee Technological University). Microhabitat of the banded sculpin, Cottus carolinae.

11:15 23. Knight, Charles L. and Robert W. Hastings. (University of Arkansas and Southeastern Louisiana University). Fishes of the Tangipahoa River system in southwest Mississippi and southeast Louisiana.

11:30 24. Rudzinski, Stanley and Christopher J. O'Bara. (Tennessee Technological University). Fishes of the Barren River system, Tennessee.

11:45 25. Timmons, Tom J. (Murray State University). Fishes of Murphy's Pond, a cypress swamp in western Kentucky.

INVERTEBRATE ZOOLOGY, Ship Isle Room

Presiding: Dr. Fred G. Howell, University of Southern Mississippi

10:00 26. Brown, Kenneth M. (Louisiana State University). Life history trade-offs and optimal offspring size: lack of support from freshwater prosobranch snails.

10:15 27. Richardson, Terry D. and Joseph F. Siebenaller. (Louisiana State University). Levels of aerobic and anaerobic enzyme activities in two populations of the southern oyster drill, *Thais haemastoma*.

10:30 28. Tarter, Donald, Dale Adkins and Mark Sheridan. (Marshall University). Acid tolerance, under continuous-flow bioassay conditions, and a preliminary study of the effects of chitinolytic activity on iono-regulation in the crayfish, *Orconectes rusticus*.

10:45 29. LaSalle, Mark W. (Vicksburg). Leaf mining of the spike-rush *Eleocharis parvula* (R. & S.) Link by the ephydrid *Hydrellia americana* Cresson.

11:00 30. Nelson, Dianne R., David Strayer and Eileen Bannon-O'Donnell. (East Tennessee State University and Institute of Ecosystem Studies, The New York Botanical Garden). Tardigrades from shallow groundwaters in southeastern New York.

11:15 31. Hackney, Courtney T. and Rosemarie F. Ganucheau. (University of North Carolina at Wilmington). A new species of anthurid isopod from southeastern North Carolina.

11:30 32. Nelson, Diane R. (East Tennessee State University). Bermuda marine invertebrates.

PLANT ECOLOGY, SESSION I, Emerald Room

Presiding: Dr. Steve Timme, University of North Alabama

10:00 33. Schott, Matthew J., Jr. and David A. White. (Loyola University of New Orleans). Morphometric analysis of two adjacent populations of *Phragmites australis* in the Mississippi River delta.

10:15 34. Luvall, Jeffrey C. and H. Richard Holbo. (Earth Resources Laboratory, NASA). The use of thermal scanner data in characterizing the thermal response of coniferous forests.

10:30 35. McCormick, J. Frank and William H. Martin. (The University of Tennessee, Knoxville and Eastern Kentucky University). The first Sino-American ecological expedition.

10:45 36. Martin, William H. and J. Frank McCormick. (Eastern Kentucky University and The University of Tennessee, Knoxville). The Yuntai ecosystem reserve: Sucheng.

11:00 37. Feil, Elisabeth G. (University of North Carolina at Charlotte). Floristics and vegetation of Chimney Rock Park, Rutherford County, North Carolina.

11:15 38. Edwards, M. Boyd. (Southeastern Forest Experiment Station). Floristic survey of a mid-Georgia Piedmont forest site one year after harvest.

11:30 39. Fralish, James S. and Fred B. Crooks. (Southern Illinois University and Center for Field Biology, LBL, Austin Peay State University). Forest communities of the northern portion of Land-Between-The-Lakes, TVA.

11:45 40. Kokesh, Amy C., David L. Edens and Dan K. Evans. (Marshall University and West Virginia State College). The bog forest community at Cranberry Glades, West Virginia: II. Understory/shrub, herbaceous and ground strata.

TEACHING, Deer Isle Room

Presiding: Dr. Ken Curry, University of Southern Mississippi

10:00 41. Henry, Betsy, Kendall Henry, Dianne Nelson and Donald Tarter. (Putnam County School System, East Tennessee State University and Marshall University). Tardigrade research - secondary school students discover first tardigrades in West Virginia.

10:15 42. Clark, Ross C. (The Morton Arboretum). The Chicago Region's cooperative college botany program.

10:30 43. Rowe, Matthew and Ken Shull. (Appalachian State University). Mark-recapture using fruit flies: a lab exercise for ecology.

POSTER SESSION I

10:00 A.M.- 5:00 P.M. Posters on Display, Pre-Assembly Area

THURSDAY AFTERNOON, APRIL 14

PAPER SESSION III

SYMPOSIUM: BIOTIC COMMUNITIES OF THE SOUTHEASTERN UNITED STATES-TERRESTRIAL COMMUNITIES

Sponsored by the SE Chapter of the Ecological Society of America

Crystal Room

Presiding: Dr. C. Ross Hinkle, The Bionetics Corporation

1:30 46. Stalter, Richard. (St. John's University). Biotic communities of the southeastern United States - maritime communities.

2:00 47. Gunderson, Lance H. and William F. Loftus. (South Florida Research Center, Everglades National Park). Biotic communities of the southeastern U. S.: The Everglades.

2:30 48. Stout, I. Jack and Wayne R. Marion. (University of Central Florida and University of Florida). Xeric pinelands of the southeastern Coastal Plain.

3:00 Break

3:30 49. Sharitz, Rebecca R., William J. Mitsch and Larry D. Harris. (Savannah River Ecology Laboratory, Ohio State University and University of Florida). Southeastern floodplain forests.

4:00 50. DeSelm, H. R. and N. Murdock. (The University of Tennessee, Knoxville, and U.S. Fish and Wildlife Service). Grasslands and certain other vegetation of the southeast.

AQUATIC ECOLOGY, SESSION I, Chandeleur Room

Presiding: Dr. Armando A. De La Cruz. Mississippi State University

1:30 51. Turner, Alan and Donald Tarter. (Marshall University). Influence of brine pollution on benthic populations in three streams of the Pocatalico River, West Virginia.

1:45 52. Price, Gregory and Mary U. Connell. (Appalachian State University). Benthic algal community structure changes associated with nutrient loading and stream recovery in the South Fork of the New River.

2:00 53. Kokesh, Amy and Donald Tarter. (Marshall University). Effects of acid-buffering capacity on the seasonal diversity and distribution of benthic populations in the Cranberry River, a naturally acidic watershed in West Virginia.

2:15 54. Taylor, Barbara E., Diane L. Mahoney and Adrienne E. DeBiase. (Savannah River Ecology Laboratory). Communities under stress: zooplankton dynamics in two cooling reservoirs.

2:30 55. McKay, Grey and Donald Tarter. (Marshall University). A preliminary study of the effects of artificial lake destratification on fish populations in Beech Fork Lake, West Virginia.

2:45 56. Brewer, Stephen and James B. Grace (Louisiana State University). Vegetation dynamics of an oligohaline tidal marsh.

3:00 Break

3:15 57. Rozas, Lawrence P., Carole C. McIvor and William E. Odum. (Waterways Experiment Station, Vicksburg, Marine Biological Laboratory, Woods Hole and University of Virginia). Intertidal rivulets and creekbanks: corridors between tidal creeks and marshes.

3:30 58. Shaffer, Gary P. (Louisiana State University). K-systems analysis for determining the factors influencing benthic microfloral productivity in a Louisiana estuary, USA.

3:45 59. Shaffer, Gary P. (Louisiana State University). A comparison of benthic microfloral production on the west and Gulf coasts of the United States: an introduction to the dynamic K-systems model.

ICHTHYOLOGY, SESSION II, Emerald Room

Presiding: Dr. Richard L. Mayden, University of Alabama, Tuscaloosa

1:30 60. Hubbs, Donald W. (Tennessee Technological University). Assessment of spawning habitat of lake trout, Salvelinus namaycush and muskellunge, Esox masquinongy in Dale Hollow Lake.

1:45 61. Baker, John A. and David C. Heins. (U. S. Army Engineer Waterways Experiment Station, Vicksburg and Tulane University). Reproductive biology of Noturus hildebrandi in the Homochitto River, Mississippi.

2:00 62. Knight, Jeremy G. (University of Southern Mississippi). Reproductive biology of the bayou darter, Etheostoma rubrum.

2:15 63. Meffe, Gary K. and David L. Certain. (Savannah River Ecology Laboratory and The University of Oklahoma). Selective mortality of post-spawning yellowfin shiners (Notropis lutipinnis).

2:30 64. Dominey, Wallace J. (Mississippi State University). Mating tactics in bluegill sunfish.

2:45 65. Bortone, Stephen A. and William P. Davis. (University of West Florida and U. S. Environmental Protection Agency, Gulf Breeze, Florida). Environmentally masculinized mosquitofish as a naturally occurring bioassay.

3:00 Break

3:15 66. Cody, Richard P. (University of West Florida). Evidence of hermaphroditism in the little head porgy, Calamus providens.

3:30 67. Cody, Richard P. (University of West Florida). Sex expression in the pinfish, Lagodon rhomboides.

3:45 68. Zieske, Glen G. (Louisiana Department of Wildlife and Fisheries). Redescription of larvae of the pinfish, Lagodon rhomboides Linnaeus.

4:00 69. Kuhajda, Bernard R. (University of Alabama, Tuscaloosa). Use of museum specimens for examining spermatozoan morphology of North American Cyprinidae genera.

PLANT ECOLOGY, SESSION II, Ship Isle Room

Presiding: Dr. Joe Winstead, Western Kentucky University

1:30 70. Muller, Robert N., Paul J. Kalisz and James O. Luken. (University of Kentucky and Northern Kentucky University). Production of astringent phenolics in fine roots over a vegetation-resource availability gradient.

1:45 71. Hull, James C. and Sarah G. Wood. (Towson State University). Soil nutrients and the distribution of oaks on serpentine soils in Maryland.

2:00 72. Ware, Stewart. (College of William and Mary). Adaptation to substrate--and lack of it--in rock outcrop plants.

2:15 73. Gibson, Joan R. (University of North Carolina, Chapel Hill). Relationship of vegetation to diabase dikes and sills of the Gettysburg Basin, Pennsylvania.

2:30 74. Greller, A. M., I. A. U.N. Gunatilleke, A. H. M. Jayasuriya, S. Balasubramaniam, C. V. S. Gunatilleke, S. Wijesundara and M. D. Dassanayake. (Queens College CUNY and University of Peradeniya, Sri Lanka). Trends in generic dominance of montane forests along a moisture gradient in Sri Lanka.

2:45 75. Wu, Xinyuan and J. Frank McCormick. (University of Tennessee). Growth patterns of red spruce populations in two spruce-fir forest stands in the Great Smoky Mountains National Park.

3:00 Break

3:15 76. Stalter, Richard, Dwight Kincaid and Eric Lamont. (St. John's University, Lehman College, CUNY and The New York Botanical Garden). Life forms and water relations of vegetation, Hempstead Plains, New York.

3:30 77. Hupp, Cliff R., William P. Carey and David E. Bazemore. (U. S. Geological Survey). Tree growth and species patterns in relation to wetland sedimentation along a reach of the Middle Fork, Forked Deer River, West Tennessee.

3:45 78. Ray, Darrell L. and Joe E. Winstead. (Western Kentucky University). Shortleaf pine as a monitor of sulfur deposition patterns on the Cumberland Plateau in Kentucky.

4:00 79. Winstead, Joe E. (Western Kentucky University). Sulfur content of wood in sweetgum and ironwood from the central United States: changes after 12 years.

4:15 80. Grace, James B., Diana Steller, Glenn Guntenspergen and Janet Keough (Louisiana State University). The relationship between salt tolerance and competitive ability in wetland plants.

4:30 81. Visser, J. M. (Louisiana State University, Coastal Ecology Institute). Production of two Sagittaria species in a developing delta, Atchafalaya Bay, Louisiana.

WETLANDS ECOLOGY AND MANAGEMENT, Deer Isle Room

Presiding: Dr. G. Ronnie Best, University of Florida

1:30 82. Day, Frank P. and J. Patrick Megonigal. (Old Dominion University and Savannah River Ecology Laboratory). Hydroperiod effects on biomass allocation and root distribution in cypress mesocosms.

1:45 83. Megonigal, Patrick, William Conner, Steve Kroeger, Rebecca Sharitz and John Day. (Savannah River Ecology Laboratory and Louisiana State University). A regional comparison of primary production in forested wetlands across topographic and flooding gradients.

2:00 84. Kroeger, Steven, William Conner, Patrick Megonigal, Rebecca Sharitz and John Day. (Savannah River Ecology Laboratory and Louisiana State University). A regional comparison of forest vegetation along topographic gradients.

2:15 85. Conner, William H., Michael Brody and John W. Day. (Louisiana State University). The impact of rising water levels on productivity and succession in Louisiana coastal wetland forests.

2:30 86. Mader, Stephen F. (North Carolina State University, Raleigh). Alteration of soil and hydrology influences growth of purple nut sedge.

2:45 87. Evers, D. Elaine and Charles E. Sasser. (Louisiana State University, Coastal Ecology Institute). Effects of herbivory on vegetation on delta islands in Atchafalaya Bay, Louisiana.

3:00 88. Robertson, David J., Rosemarie Garcia and Kathryn Piwowar. (Florida Institute of Phosphate Research). Viability of stockpiled peat for wetland reclamation.

POSTER SESSION I

Pre-Assembly Area

Presenters with Posters 4:00 P.M.- 5:00 P.M.

4:00 89. Cappellato, R. and M. Eloise Brown Carter. (Emory University). Successional changes in a piedmont deciduous forest at Panola Mountain State Conservation Park (1977-1986).

4:00 90. DeLaune, R. D., J. H. Whitcomb and W. H. Patrick. (Laboratory for Wetland Soils and Sediments, Louisiana State University). Marsh aggradation along the rapidly submerging Louisiana Gulf Coast.

4:00 91. Pezeshki, S. R. and R.D. DeLaune. (Laboratory for Wetland Soils and Sediments, Louisiana State University). A comparative study of carbon assimilation and productivity of streamside and inland Spartina alterniflora.

4:00 92. Webb, Doshia and Thomas E. Weaks. (Marshall University). Periphyton community structure of an artificially destratified lake.

4:00 93. Rogers, David S. and Thomas E. Weaks. (Marshall University). An analysis of phytoplankton and zooplankton on an artificially destratified lake.

4:00 94. Norman, Robert and Donald Tarter. (Marshall University). Effects of artificial destratification on the benthic populations in Beech Fork Lake, West Virginia.

4:00 95. Culp, Carolyn and Thomas E. Weaks. (Marshall University). Periphyton community structure along thermal gradients in Beech Fork Lake, West Virginia, utilizing artificial substrates.

4:00 96. Quinn, P. Michael, Jr. and Clay M. Chandler. (Middle Tennessee State University). Seasonal variations in populations of crustaceans of a temporary pond in Murfreesboro, Tennessee.

4:00 97. Congdon, Justin D. and Harold Avery. (Savannah River Ecology Laboratory and University of California at Los Angeles). Reproductive frequency of macho female snapping turtles.

FRIDAY MORNING, APRIL 15

PAPER SESSION IV

SYMPOSIUM: BIOTIC COMMUNITIES OF THE SOUTHEASTERN UNITED STATES-AQUATIC COMMUNITIES

Crystal Room

Sponsored by the SE Chapter of the Ecological Society of America

Presiding: Dr. C. Ross Hinkle, The Bionetics Corporation

8:30 98. Smock, Leonard. (Virginia Commonwealth University). Ecological characteristics of southeastern U.S.A. blackwater streams.

9:00 100. Pearson, William D. and B. Juanelle Pearson. (University of Louisville). Streams and medium-sized rivers in the Mississippi River drainage of the southeastern U. S.

9:30 101. Miller, Andrew C. and C. H. Pennington. (U.S. Army Engineer Waterways Experiment Station, Vicksburg). Physical and biological characteristics of the Tombigbee River.

10:00 Break

10:30 102. Crisman, Tom L. (University of Florida). The structure and function of natural lakes of the warm temperate- subtropical transition in the southeastern United States.

11:00 103. Schroeder, William W., M. R. Dardeau, J. P. Stout and R. F. Modlin. (University of Alabama- Dauphin Island Sea Lab, University of South Alabama, University of Alabama). Southeastern Estuaries.

SYMPOSIUM: ECOLOGY OF MESIC FOREST HERBS

Chandeleur Room

Presiding: Drs. Beverly Collins and Gary Wein, Savannah River Ecology Laboratory

8:30 104. Collins, Beverly S. (Savannah River Ecology Laboratory). Organization of forest herb communities

9:00 105. Baskin, Carol C. and Jerry M. Baskin. (University of Kentucky). Ecology of mesic forest herbs: Germination ecophysiology and evolutionary aspects.

9:30 106. Baskin, Jerry M. (University of Kentucky). Ecology of mesic forest herbs: Ecophysiology of photosynthesis.

10:00 Break

10:30 107. Muller, Robert M. (University of Kentucky). Patterns of influence of the herbaceous layer on nutrient cycling in mesic forests.

11:00 108. Motten, Alexander F. (Duke University). Pollination, resource availability, and seed-set in two North Carolina populations of Erythronium umbilicatum.

11:30 109. Wein, Gary R. (Savannah River Ecology Laboratory). Demography of clonal forest herbs.

ANIMAL ECOLOGY, Deer Isle Room

Presiding: Dr. Ted Simons, Gulf Islands National Seashore, National Park Service

8:30 111. Folkerts, George W. and Ronald D. Cave. (Auburn University and Escuela Agricola Panamericana). Avoidance of ant attack by the larvae of the myrmecophilous syrphid fly, Microdon sp.: microstructure and behavior.

8:45 112. Hopkins, Thomas S. and Brian Hughes. (University of Alabama, Marine Science Program). Experimental studies of salinity tolerance in Branchiostoma floridae Hubbs.

9:00 113. Smith, Albert K., Cletus M. Sellers, Jr. and Norman E. Garrison. (James Madison University). The effects of acidification on plasma protein concentrations of rainbow trout (Salmo gairdneri).

9:15 114. Gravitt, B. L., E. L. Morgan, W. L. Pennington and T. P. Weaver. (Tennessee Technological University and Tennessee Department of Health and Environment). Effects of rain event induced water quality changes on rainbow trout breathing rates.

9:30 115. Jones, Lee R. (Emory University). High and low temperature tolerances of black-billed magpie embryos and the thermal environment of roofed and roofless nests.

9:45 116. Mills, Edward D. and David T. Rogers, Jr. (University of Alabama). Wintering migrant-resident bird ratios in Belize, Central America.

10:00 Break

10:15 117. Ranglack, Georganna S. and Ken R. Marion. (University of Alabama, Birmingham). Demographics of a heron rookery: observations on controlling factors.

10:30 118. Lambert, Edward P. and Winston Paul Smith. (Southeastern Louisiana University and Tennessee Technological University). Age and sex differences in seasonal movements and habitat use by Eastern Wild Turkey in a farmland - timberland interspersion.

10:45 119. Barry, Ronald E., Jr. (Frostburg State University). Microhabitat selection and dispersion by three syntopic rodents in Maryland.

11:00 120. Greenberg, C. H. and P. D. Carr. (University of Tennessee and Oak Ridge National Laboratory). Gray fox ecology: food habits, habitat use, and home range on the Oak Ridge National Environmental Research Park.

HERPETOLOGY, Ship Isle Room

Presiding: Dr. James S. Rodgers, University of New Orleans

8:30 121. Bailey, Mark A. and Robert H. Mount. (Auburn University). Movement of the dusky gopher frog at a breeding pond in the lower coastal plain of Alabama.

8:45 122. Harkey, Gail A. and Raymond D. Semlitsch. (Memphis State University). Effects of temperature on the growth, development and color polymorphism in the ornate chorus frog, Pseudacris ornata.

9:00 123. Forester, Don C. and David V. Lykens. (Towson State University). The ability of wood frog eggs to withstand prolonged terrestrial stranding: an empirical study.

9:15 124. Voss, S. R. (Western North Carolina University). Inter- and intra-populational variation in age-specific metamorphic frequency and larval growth in southern Appalachian populations of Eurycea wilderae

9:30 125. Scott, David and J. W. Gibbons. (Savannah River Ecology Laboratory). The effect of metamorph body size on adult body size and survival in the marbled salamander, Ambystoma opacum

9:45 126. Estes, Ruth A. and David E. Scott. (Savannah River Ecology Laboratory). Lipid utilization by adult marbled salamanders Ambystoma opacum) during the breeding season.

10:00 Break

10:15 127. Anderson, Roger A. (Savannah River Ecology Laboratory). Sexual dimorphism and sexual selection in the lizard Cnemidophorus tigris.

10:30 128. Fischer, Robert U., David E. Scott, Scott A. Busa and Justin D. Congdon. (Savannah River Ecology Laboratory). Reproductive and lipid cycles in the cottonmouth Agkistrodon piscivorus.

10:45 129. Diller,Lowell, V. and Richard L. Wallace. (Frostburg State University and University of Idaho). Feeding ecology of the northern Pacific rattlesnake (Crotalus viridis oreganus).

11:00 130. Blair, Ken and Beverly Knauper. (Cumberland College). ELISA-Immunoassay of snake venoms.

11:15 131. Jackson, James F. (University of Southwestern Louisiana). Predator avoidance and crevice occupation by musk turtles.

PLANT ECOLOGY, SESSION III, Emerald Room

Presiding: Dr. Paul Schmalzer, The Bionetics Corporation

8:30 132. Dunn, Christopher P., Rebecca R. Sharitz and Robert C. Kelly. (Savannah River Ecology Laboratory). Phenotypic plasticity in Aneilema keisak: field and green house experiments.

8:45 133. King, Bruce L. (Randolph-Macon College). Germination ecophysiology of false foxglove, Aureolaria virginica.

9:00 134. Carter, M. Eloise Brown and Elizabeth Guthrie. (Emory University). Genetic variation in Trillium persistens, a federally endangered species.

9:15 135. Porch, Susan S. and George W. Folkerts. (Auburn University). Leaf lifespan and trapping area in three species of Gulf Coast Drosera.

9:30 136. Folkerts, Debbie R. and D. A. Crossley, Jr. (Auburn University and University of Georgia). Pitcher plant prey: a limited resource?

9:45 137. Folkerts, George W. (Auburn University). Dispersal types in the flora of pitcher plant habitats in the southeastern U. S.

10:00 Break

10:15 138. Wilczynski, Carolyn J. and Katherine L. Gross. (University of North Carolina and Kellogg Biological Station, Michigan State University). Small scale disturbance and seedling dynamics of two species of Hieracium in an old field.

10:30 139. Wilson, Allan D. and Donald J. Shure. (Emory University). Effects of the herb-shrub layer on black-locust (Robinia pseudo-acia) growth.

10:45 140. McLeod, Kenneth W. and Michael A. Cascarina. (Savannah River Ecology Laboratory and Villanova University). Use of artificial shade environments to predict natural responses.

11:00 141. Bennett, B. D. and James Grace. (Louisiana State University). Shade tolerance and its effect on the segregation of two species of Louisiana iris and their hybrids.

11:15 142. Crooks, Fred B. and James S. Fralish. (Southern Illinois University, Carbondale). A comparison of presettlement and existing forest conditions in the Shawnee Hills of Illinois.

11:30 143. Frost, Cecil C. and Allen E. Plocher. (University of North Carolina and Old Dominion University). Restoration of fire communities on a preserve in southeastern Virginia.

11:45 144. Klimas, Charles V. (U.S. Army Engineer Waterways Experiment Station, Vicksburg). Forest degradation and preservation in a developed landscape.

PLANT SYSTEMATICS, SESSION I, Caprice Room

Presiding: Dr. Charles Horn, Newberry College

8:30 145. McGuire, Robert F. (University of Montevallo). Numerical taxonomic investigations of selected filamentous non-heterocystous Cyanobacteria.

8:45 146. Keller, Harold W. (The University of Texas at Arlington). A new species of Physarum with wrinkled-reticulate spores.

9:00 147. Wallace, James W. and Susan L. Strum. (Western Carolina University). Flavonoids of Psilotum (Psilotaceae).

9:15 148. Davenport, L. J. (Samford University). The Lemnaceae (duckweeds) of the southeastern United States.

9:30 149. Matthews, James F., James R. Allison and Wayne R. Faircloth. (University of North Carolina at Charlotte, Lawrenceville, GA and Valdosta State College). A Portulaca species new to the United States.

9:45 150. Lievens, Alan W. and Lowell E. Urbatsch. (Louisiana State University). The Indigofera miniata Ortega complex in Texas.

10:00 Break

10:15 151. Murrell, Zack E. (Duke University). A phylogenetic analysis of the genus Cornus (Cornaceae).

10:30 152. Cox, Patricia B. and Lowell E. Urbatsch. (Louisiana State University). A phenetic analysis of the Rudbeckia nitida Nutt. complex (Asteraceae: Heliantheae).

10:45 153. Bounds, Richard R. (Mount Olive College). Patterns of isozyme variation in Iliamna corei (Sherff) Sherff.

11:00 154. Flory, Walter S. and Gerald L. Smith. (Wake Forest University). A chromosome classification for the Zephyrantheae.

11:15 155. Evans, Dan K. and Joan B. Estep. (Marshall University). The origin and status of Carex xdeamii Hermann.

POSTER SESSION II

10:00 A.M.- 5:00 P.M. Posters on Display, Pre-Assembly Area

FRIDAY AFTERNOON, APRIL 15

PAPER SESSION V

AQUATIC ECOLOGY, SESSION II, Caprice Room

Presiding: Dr. Barbara E. Taylor, Savannah River Ecology Laboratory

2:00 156. DeBiase, Adrienne E., Robert W. Sanders and Karen G. Porter. (Savannah River Ecology Laboratory and The University of Georgia). Relative nutritional value of algal and protozoan food sources for Daphnia.

2:15 157. Pride, Thomas, E., Winston P. Smith and Michael J. Harvey. (Tennessee Technological University). Determination of sample size for analysis of species diversity indices.

2:30 158. Mahoney, Dianne L., Mona A. Mort and Barbara E. Taylor. (Savannah River Ecology Laboratory). Zooplankton are diverse in Carolina Bays.

2:45 159. Turner, M. Randall, Hazel R. Delcourt, Paul A. Delcourt and Frederick W. Harrison. (Western Carolina University and University of Tennessee, Knoxville). Paleolimnological and paleoecological study of Jackson Pond, Kentucky, utilizing fossilized remains of freshwater sponges.

3:00 Break

3:15 160. Matthews, Kimberly and Donald Tarter. (Marshall University). Ecological life history, including laboratory respiratory studies, of _Ameletus_ _tarteri_ Burrows in the Cherry River, West Virginia.

3:30 161. Glover, James and Donald Tarter. (Marshall University). Emergence patterns of leptocerid caddisflies from West Virginia (Trichoptera: Leptoceridae).

3:45 162. Miller, Andrew C. and Paul D. Hartfield. (U.S. Army Engineer Waterways Experiment Station, Vicksburg). Characterization of a dense mussel bed in the Sunflower River, Sharkey Co., Mississippi.

ICHTHYOLOGY, SESSION III, Ship Isle Room

Presiding: Dr. Stephen A. Bortone, University of West Florida

2:00 163. Williams, James D. and Dawn P. Jennings. (U. S. Fish and Wildlife Service, National Fisheries Research Center). Preliminary observations on the exotic fishes of the Indian River system, Florida.

2:15 164. Thompson, Bruce, Jeffrey Render, Gary Peterson and W. Wayne Forman. (Louisiana State University and Freeport McMoran, Inc.). Preliminary information on fishes of Louisiana's barrier islands.

2:30 165. Mitchell, Michael E., Kristie A. Killam, Randall J. Hochberg and Robert H. McMichael, Jr. (Florida Department of Natural Resources, Bureau of Marine Research). Gear development for a long term juvenile fish monitoring program in Tampa Bay, Florida: Trawls.

2:45 166. Killam, Kristie A. and Randall J. Hochberg. (Florida Department of Natural Resources, Bureau of Marine Research). Use of portable drop nets in estimating density, diversity, and biomass of juvenile fish and macroinvertebrates in shallow estuarine systems.

3:00 Break

3:15 167. McMichael, Robert H., Jr. (Florida Department of Natural Resources, Bureau of Marine Research). Population dynamics of red drum (_Sciaenops_ _ocellatus_) in a small canal off the Alafia River, Tampa Bay, Florida.

3:30 168. Hastings, Robert W. (Southeastern Louisiana University). Seasonal recruitment patterns of bay anchovy (Anchoa mitchilli) into the upper Lake Pontchartrain estuary.

3:45 169. Schwartz, Frank J., James Tyler and Suzanne Hill. (Institute of Marine Sciences, University of North Carolina and N.C. Division of Marine Fisheries). Massive migratory congregations of the cownose ray, Rhinoptera bonasus, off North Carolina and of rhinopterids worldwide.

PARASITOLOGY, Chandeleur Room

Presiding: Dr. Jeff Lotz, Gulf Coast Research Laboratory

2:00 170. Joy, James, E. (Marshall University). Monthly length class frequencies of Microcotyle spinicirrus from the freshwater drum, Aplodinotus grunniens, in West Virginia.

2:15 171. Joy, James E. and Elio Madan (Marshall University). Larval tapeworm infections in largemouth and spotted basses taken from Beech Fork Lake, West Virginia.

2:30 172. Porch, John R. (Auburn University). Acarine parasites of the cattle egret (Bubulcus ibis ibis) in Alabama.

PLANT SYSTEMATICS, SESSION II, Deer Isle Room

Presiding: Nancy Coile, University of Georgia, Athens

2:00 173. Robinson, Kent. (Appalachian State University). Marianne North (1830-90), Botanic artist and confidant of Charles Darwin.

2:15 174. Dale, Thomas R. and Charles M. Allen. (Northeast Louisiana University and Louisiana State University). A status report on the flora of Louisiana project.

2:30 175. Soblo, Dale C. and John E. Fairey III. (Clemson University). The flora of Givhan's Ferry State Park.

2:45 176. Fairey, John E., III, Caroline C. Douglass Aldrich and Steven R. Hill (Clemson University). Success of transplants from the basin of the Richard B. Russell Lake.

3:00 177. Blackwell, Will H., Martha J. Powell and George H. Dukes. (Miami University, Ohio, Belhaven College, and Millsaps College). Fossil wood in Mississippi gravel deposits.

3:15 178. Perry, James W. and Carole A. Wooden. (Frostburg State University). Phloem ultrastructure in the shoot of Monotropa uniflora.

3:30 Break

3:45 179. Levy, Frosty. (Duke University). The genetic basis of reproductive incompatibilities in the Phacelia dubia (Hydrophyllaceae) complex.

4:00 180. Mellichamp, T. Lawrence and Deborah Brown Way. (University of North Carolina at Charlotte). Stimulating germination and growth in Sarracenia pitcher plant seedlings.

4:15 181. Horn, Charles N. (Newberry College). Variation in floral morphology and reproductive strategy of *Heteranthera dubia*.

4:30 182. Ware, Donna M. E. (College of William and Mary). Demographic studies of the small whorled pogonia, *Isotria medeoloides* (Pursh) Raf., in Virginia.

4:45 183. Wofford, B. Eugene and Ronald W. Jones. (University of Tennessee and Eastern Kentucky University). *Fimbristylis perpusilla* Harper from the Cumberland Plateau of Tennessee.

POSTER SESSION II

Pre-Assembly Area

Presenters with Posters 4:00 P.M.- 5:00 P.M.

4:00 184. Herring, Theresa, Anne Stevens and M. Gunasekaran. (Fisk University). *In vitro* synthesis of amylase in *Nocardia asteroides*.

4:00 185. Sharma, Sanjeev, Barbara Samples, H. Wayne Elmore and Marcia Harrison. (Marshall University). Affect of cultural and environmental parameters on the stability of ascorbate in plant tissue culture medium.

4:00 186. Bauman, T. R., J. M. Wilman and E. A. Cross, Jr. (University of Alabama, Tuscaloosa). The effects of photo and thermoperiods on the eclosion of *Trypoxylon politum*.

4:00 187. Sedivec, M. J., M. A. Dunnigan, A. M. Kavookjian, A. R. Light. (Appalachian State University and University of North Carolina, Chapel Hill). Local axon collaterals from spinal laminae I and II which project to the brain stem.

4:00 188. Briley, Glenn P. and John A. Knesel. (Northeast Louisiana University). Effect of ovulation and pregnancy on oviductal lactate dehydrogenase (LDH) activity in the mouse.

4:00 189. Pool, W. F., P. A. Crooks and P. M. Zavos. (University of Kentucky). Double label studies with R-(+)-[^3H-N'-CH_3; ^{14}C-N-CH_3]-N-methylnicotinium acetate *in vivo* in the guinea pig.

4:00 190. Pool, W. F., P. A. Crooks and P. M. Zavos. (University of Kentucky). Retention of radiolabel in the male reproductive organs of the guinea pig after exposure to a ^{14}C-nicotine metabolite.

4:00 191. Zavos, P. M., G. W. Gregory and R. Grove. (University of Kentucky). Diurnal distribution of spermatozoa in urine of rams.

4:00 192. Haynes, Janice, Caretha Brandyburg and Jim Ross. (Benedict College). Effects of chilling injury temperature on chloroplast lipids.

ABSTRACTS

1

AULT, JAMES R. University of Georgia--Plant propagation, preservation, and breeding through cell and tissue culture.

The ability to culture plant organs, tissues, and cells in vitro has significant practical and research applications. Techniques for micropropagation (meristem, shoot tip, or bud culture), organogenesis (shoot initiation from cell cultures), and embryogenesis (embryo initiation from somatic tissues) have been applied to the asexual propagation of a wide range of economically important plants. Micropropagation techniques are those most commonly employed on a commercial scale, as up to thousands of phenotypically identical plants can be produced from a single explant. Organogenic and embryogenic systems may produce a greater number of plants per explant than obtainable through micropropagation, but plants produced from the former tend to be more genetically variable. This variation is being exploited to introduce novel, economically useful traits into plant breeding programs. Additional tissue culture techniques that can potentially contribute to plant improvement programs include 1) immature ovule culture, producing wide hybrid crosses not obtainable through conventional breeding practices; 2) haploid plant production from pollen culture, which may be utilized in mutation detection and for rapid production of homozygous plants; and 3) protoplast fusion, allowing the production of interspecific somatic hybrid plants.

2

GEORGE, V.G. AND ADES, E.W. Centers for Disease Control, Biological Products Branch, Atlanta, GA 30333--Mammalian cell lines for biological products.

In vitro cultivation of mammalian cells constitutes one of the landmarks in biological science. It opened the door for modern diagnostic virology, production of viral vaccines, and ultimately was the key that unlocked the mystery of the molecular structure of viruses and the cells themselves. In the last 20 years further discoveries have made possible the production of biological products from cells whose potentials have only begun to be explored. The discovery by Kohler and Milstein of hybridomas and monoclonal antibody production revolutionized immunology. These antibodies and their potential for therapeutic applications are only beginning to be understood. Advances in molecular biology have opened the way for the immunologist to unravel the mysteries of the immune response. Cellular products or lymphokines/cytokines produced by mammalian cells in culture have been demonstrated to be the messengers and growth factors necessary for the immune system to function (i.e., the chemicals that orchestrate the system). Growth factors, as well, have been shown to exist and are required for almost every kind of cell in order to propagate. Additionally, biological products of cells have opened the door for examination of the theories of germ line versus somatic mutation. In this program, these landmark discoveries and their implications will be briefly discussed along with "how to" information for generating a self-perpetuating mammalian tissue culture. This information will aid in demonstrating the requirements of growth factors for human cells of lymphoid origin.

3

GARST, DAVID G. and DAVID R. HARTMAN. Western Kentucky University--Some Properties of a Carboxylesterase from Wax Moth, Galleria mellanella, Larvae.

A carboxylesterase was partially purified from wax moth larvae by ammonium sulfate fractionation. Half-life of the enzyme in 60% saturated ammonium sulfate at 4°C, pH 7.85, in TRIS buffer was increased from two days to three weeks by using phenylmethylsulfonyl fluoride (PMSF), a protease inhibitor. A new assay procedure for the carboxylesterases was evaluated. The substrate in this procedure, acetyl-p-hydroxybenzoic acid, undergoes hydrolysis considerably faster than the substrates commonly used in assays, esters of m-hydroxybenzoic acid, o-hydroxybenzoic acid and 1-naphthol.

4

WALTON, JULIE and JAMES B. CLAIBORNE. Georgia Southern College--Acid-base regulation in a stenohaline fish (Myoxocephalus octodecimspinosus) during exposure to low salinities.

In order to make the transition from seawater to fresh water, a fish must be able to alter ion transfers that may perturbate acid-base regulation. We have examined the role of acid-base regulation in long-horned sculpin during long-term exposure to the following dilute water salinities: 160 mM, 40 mM, or 20 mM (measured as Cl^- concentration). Blood samples were collected and analyzed for changes in pH, T_{CO_2}, and $[Cl^-]$. Water samples were monitored for changes in $[HCO_3^-]$, NH_4^+, and H^+. While fish exposed to the 160 mM dilution lived for the length of the experiment (up to 10 days), the 40 and 20 mM groups exhibited significant mortality within 24-48 hours. Plasma $[Cl^-]$ (control: 160 mM ± 2.25, mean ± S.E., n=7) decreased significantly over time in the 40 and 20 mM dilution groups with the maximum decrease observed in the 20 mM fish as $[Cl^-]$ fell to 104.6 ± 3.84, n=3, at hour 24. Plasma $[HCO_3^-]$ did not change significantly for any group and plasma pH values showed no change from the control value of 7.75 ± 0.033 (n=7). Analysis of water samples revealed that fish were gaining H^+ from (or losing HCO_3^- to) the dilute water, and the rate of this net base loss was proportional to the decrease in water salinity. Clearly, exposure to a dilute environment induces a net base loss to the water. It remains to be seen whether loss of acid-base balance is the cause of the final expiration of the fish, or if this is just a secondary effect linked to the diffusive loss of NaCl. Funded by NSF DCM 86-02905 to JBC.

5

MOONEY, RICHARD L. AND T. D. KIMBROUGH. VIRGINIA COMMONWEALTH UNIVERSITY-- Purification of serotonin-binding proteins from the ileum-anterior colon of the American cockroach.

The serotonin-binding proteins from the mucosa and submucosa have been solubilized by treatment with 0.5% triton x-100 and sonication. Molecular sieve chromatography on polyacrylamide P-200 indicates that the binding proteins have a molecular weight greater than 133,000 daltons. Column chromatography on diethylaminoethyl (DEAE) cellulose shows that the binding proteins are basic or neutral at a pH of 7.6. Binding assays utilized the incubation of the purified binding proteins with ascorbic acid and pargyline to inhibit monoamine oxidase. Radioactive 14-C serotonin was found to bind to the neutral or basic proteins. Isolation of the radioactive proteins was accomplished by removing unbound 14-C serotonin by P-4 polyacrylamide gel column chromatograpny. These results suggest that serotonin binding sites are insoluble and occur as cell membrane-bound proteins. The proteins have been solubilized by detergent extraction and found to be basic or neutral in character and have a molecular weight above 100,000 daltons.

6

KIMBROUGH, T. DANIEL AND RICHARD MOONEY. VIRGINIA COMMONWEALTH UNIVERSITY-- Effects of Serotonin S_2 Antagonists, Ketanserin and Ritanserin on Serotonin-Induced Myopathies in Albino Mice.

Contrary to the assumption by some investigators that skeletal muscle myopathies are induced by serotonin acting at vascular smooth muscle receptors alone, recent studies have suggested that multiple binding sites are involved. When given I.P. at a dosage of 1 x 10^{-6} M, serotonin not only reduces hind limb motion, but causes general flaccidity and debilitation of the affected tissue. Albino mice were given ketanserin or ritanserin *ad libitum* during a three-phase study. Each phase lasted five days, during which time the antagonist drugs were mixed into ground rodent chow so that the animals ingested levels of these chemicals confirmed at 5-10 mg/kg b.w. daily. Not only did these drugs promote immediate healing of the myopathies, but they restored contractile responses to values as high as 108% of control for ketanserin and 140% of control for ritanserin. The results also suggested that the receptor antagonists which block serotonin's action in skeletal muscle are different from those which restrict vasoconstrictor activity as well as from those which are known to inhibit serotonin's stimulation of gut muscle motility.

7

P.M. Zavos, S.K. Hunt, D.R. Varney, R.W. Hemken and M.R. Siegel. University of Kentucky -- Effects of feeding endophyte-infected tall fescue seed on reproductive performance in male CD-1 mice via competitive breeding.

The objective of this study was to assess the effects of endophyte-infected tall fescue (KY-31) seed (80% infected, containing *Acremonium coenophialum*) on the reproductive performance in male CD-1 mice measured via competitive breeding. Sixteen mature CD-1 male mice were randomly allocated to two dietary treatments (DTs) containing 50% mouse chow and (1) 50% non-infected tall fescue seed, restricted to the daily feed intake of 2 (2) 50% infected tall fescue seed (w/w) fed ad libitum. Mice were preconditioned on their respective diets for an average of 54.0 days prior to 96 hours of cohabitation with 10 mature CD-1 females. Following removal of males the females were carried to full term. Males were sacrificed and testicular, epididymal weights, sperm motility and progressive sperm motility were assessed. The data were statistically analyzed by variance techniques. The results showed no differences (P>0.05) in average daily gain and body weight changes during the course of the experiment between the two DTs. There were significant reductions (P<0.05) in total testes weight (.238 vs .214 g), epididymal weight (.087 vs .073 g), sperm motility (82.5 vs 58.7%), and progressive motility (3.7 vs 2.6; scale 0-4) between DTs 1 and 2, respectively. Similarly, pregnancy rates were 53.8% and 45.0% and the average number of pups born per litter were 10.67 and 9.84, respectively. These data suggest that 50% fungal infected fescue seed in the diet of CD-1 mice can affect their reproductive capacity by influencing the testicular-epididymal weights and subsequently their quality of spermatozoa and overall fecundity.

8

Wiles, L.A.[1], D.R. Varney[1], M.R. Siegel[2] and P.M. Zavos.[2] Eastern Kentucky University[1] and University of Kentucky[2] -- Mouse pup growth through weaning as affected by endophyte infected tall fescue.

This study was designed to assess the effects of endophyte (Acremonium coenophialum) infected tall fescue on the suckling ability and litter performance in CD-1 mice. Twenty pairs of mature CD-1 mice were allocated to two dietary treatments containing 50% rodent chow and (1) 50% infected tall fescue seed fed ad libitum; (2) 50% noninfected tall fescue seed (w/w) limited to intake of Diet 1. At parturition six pups of equal weight and sex ratio were selected from each litter and fostered to either Diet 1 or Diet 2 dams resulting in four suckling combinations (n=5): (1) Diet 1 pups vs Diet 1 dams, (2) Diet 1 pups vs Diet 2 dams, (3) Diet 2 pups vs Diet 2 dams, and (4) Diet 2 pups vs Diet 1 dams. Pups born to Diet 1 dams weighed less at birth than Diet 2 and experienced developmental delays. Group 3 and 4 pups attained the greater growth rates and weaning weights with group 3 showing the largest ($P<.05$) gains. Growth rate and weaning weight of Group 2 coincided closely with Group 4 being only slightly lower. Group 1 demonstrated reduced ($P<.05$) growth rates and weaning weights. Groups 2 and 4 showed less weight gain than Group 3. Group 1, however, remained significantly lower than Groups 2, 3 or 4 throughout the total period (21 d). These results suggest that the effect on pups born of dams fed an infected fescue diet is real ($P<.05$) in lowering the growth rate of the pups during suckling. The Diet 1 dam's ability to lactate is also lowered ($P<.05$). When these two factors are combined the results are even more dramatic.

9

Varney, D.B.[1], Z.A. Ruhman[1], R. Stamper[1], L.P. Bush[2], M.R. Siegel[2], and P.M. Zavos.[2] Eastern Kentucky University[1] and University of Kentucky[2] -- Growth and reproduction in female rats fed a diet containing a serial extract of endophyte infected tall fescue seed.

A serial methanol extract of endophyte (Acremonium coenophialum) infected tall fescue seeds was fed to female rats to assess the effects of pyrrolizidine alkaloids (PA) on their growth and reproductive potential. Twenty-one female Sprague-Dawley rats (125 g) were assigned to one of three dietary treatments (N=7) containing 50% rodent chow (w/w) and 50% noninfected tall fescue seed (KY-31). The diets were: (1) as described; (2) as in 1, but treated with an extract of similar weight of endophyte infected tall fescue seeds; and (3) as in 2, but treated with similar extract of noninfected tall fescue seeds. The animals were housed separately under a 12:12 h photoperiod on their respective diets for 14d, at which time a male of similar age was placed with each female and rotated from cage to cage (daily) for a period of 5d and then removed. The females were kept on their respective diets through parturition. Litters were assessed at birth and the females were sacrificed and their uteri were examined for implantation scars. Weights of several organs were also determined. Statistical analysis showed reduced ($P<0.05$) percent pregnancy in animals fed Diet 2. Similarly, these animals had lower ($P>0.05$) mean litter weights, ovarian and uterine weights and higher spleen weights. The number of pups/dam and the mean area of uterine scars were lower ($P<0.05$) for animals fed Diets 2 and 3. These results suggest that PA could be only partially responsible for the fescue toxicosis reported in rats fed a diet containing endophyte infected tall fescue seed.

10

HAMILTON, JANET C. and TRELAWNY, G. S. James Madison University, Harrisonburg, VA--Partial purification and characterization of arginase from Phlyctochytrium semiglobosum

Arginase, extracted from cultures of Phlyctochytrium semiglobosum, was partially purified and characterized. Purification steps included protamine sulfate and ammonium sulfate fractionation followed by gel filtration and ion exchange chromatography. The highest purification factor obtained was 11-fold. The enzyme appeared to be quite labile to purification procedures. Optimal temperature for activity was 46° C, and the pH optimum was 9.0. Activity was highest when the enzyme was preincubated with 0.25 mM $MnCl_2$ at 50° C for 10 minutes. Molecular weight was estimated at 105,000 daltons by gel filtration through Sephadex G-200. The characteristics of arginase from P. semiglobosum were similar to those reported for the enzyme from a variety of other organisms.

11

HILL, DONNA R. and VALGENE L. DUNHAM. Western Kentucky University--DNA Replicating Enzymes in Soybean (Glycine max) and in Healthy and CaMV-infected Turnip (Brassica rapa).

The three major eukaryotic DNA plymerases α, β, and γ have been identified in various plants. The focus of this paper is the isolation, characterization and comparison of DNA polymerase α and γ from etiolated soybean and light grown healthy and cauliflower mosaic virus-infected turnip seedlings. Reverse transcriptase activity in the viral infected host will be examined. DNA polymerase α and γ were found in the soluble fraction of a nuclear preparation and partially purified with ammonium sulfate precipitation, DEAE-cellulose and phosphocellulose chromatography, and electrophoresis in a non-denaturing polyacrylamide gel. DNA polymerase α was inhibited by low concentrations of salt and aphidicolin and preferred magnesium as the divalent cation. DNA polymerase γ preferred manganese and was inhibited by aphidicolin only at high concentrations. Properties of these enzymes will be compared and discussed with respect to purification, regulation, and major physical characteristics.

12

MORTON, DAVID. Frostburg State University--Staining and Histochemistry of Fe^{+3} Positive Pigments in the GI Tract of an Obligate Sanguivore, the Common Vampire Bat (Desmodus rotundus).

Fe^{+3} positive pigments are common in both mucosal epithelial cells and mononuclear phagocytes. As both Fe absorption and body Fe turnover are relatively low (Morton and Janning, 1982), these pigments must trap Fe taken up by the GI tract, thereby blocking the transfer of Fe to internal pools. Much of this iron is lost when effete epithelial cells are shed into the lumen. Whenever possible, the staining and reactions of the Fe^{+3} positive pigments in the GI tract, liver, and spleen were studied in serial 2 micron sections of glycol methacrylate embedded material. Results were essentially the same for each organ and were consistent with those described for hemosiderin. The presence of acid phosphatase suggested lysosomal involvement in the genesis of the pigments. Extraction of Fe with 1% $Na_2S_2O_4$ in 0.1 M acetate-HCl buffer (pH 4.5) removed the ocher color of the pigments but did not interfere with the PAS, alloxan-Schiff, ferric ferricyanide, methenamine silver, thiazine dye, Nile blue A, and Sudan procedures. Diffuse but intense Prussian blue staining for Fe^{+3} outside of the pigment granules was also PAS positive, indicating an Fe binding molecule in other cellular compartments more complex than apoferritin. Diffuse Prussian blue staining has been previously interpreted as indicating the presence of ferritin, despite its high solubility in aqueous solutions.

13

DENNISTON, KATHERINE J.,[1] W. GERARD ROBEY,[2] AND DANIEL K. HAAPALA.[1] Towson State University[1] and Abbott Laboratories[2] -- Isolation and characterization of an endogenous feline retrovirus with a novel coat protein.

Two endogenous feline retroviruses were isolated from 6DDK cells. Both isolates are similar to the previously isolated RD-114 virus. One isolate, L1L, shares all coat antigens with RD-114. The other, L2LL, is not neutralized by antisera raised against either the RD-114 or feline leukemia envelope glycoproteins. L1L and L2LL do not show cross interference with one another. They have the same host range and induce foci on cells that are permissive for RD-114, but not on cells that are restrictive for that virus. Peptide maps show homology between the capsid proteins of L1L, L2LL and RD-114. However, the envelope glycoprotein of L2LL is distinct from those of L1L or RD-114. Viral DNAs have been purified from Hirt extracts of infected cells. These were digested with a number of restriction enzymes and compared by Southern hybridization. L1L and L2LL are identical in the restriction maps of their 5' sequences (5000 base pairs). Their maps differed in the 3' region of approximately 4000 base pairs. The region of the genome in which these two isolates are different corresponds to the envelope glycoprotein genes. A cloned fragment of feline cell DNA from a genomic library has been used as a hybridization probe with Southern transfers of L1L and L2LL DNAs. This probe detected only sequences corresponding to the envelope glycoprotein of L2LL. We take these data to indicate that L2LL arose from recombination between an endogenous cat virus like L1L and a previously undetected integrated retrovirus.

14

RAMESH, MARILEE A. and S. K. BALLAL. Tennessee Technological University--The isolation and culture of Jojoba (Simmondsia chinensis) protoplasts.

Jojoba is a xerophyte native to the Sonoran desert. The liquid wax contained in it is of such a high quality that the plant has attracted a great deal of interest among researchers. In recent years, various propagation techniques have been attempted in order to get genetically identical clones from the female plant. In this study, protoplasts from Jojoba were isolated from the cotyledonary tissues, and callus cultures established from cotyledonary explants. Various concentrations and combinations of macerozyme, hemicellulose and driselase were used for the enzymatic degradation of cell wall components to release viable protoplasts. The osmoticum used was 13% mannitol. Viability of protoplasts was determined with Evans Blue staining technique, and the viable protoplasts were sorted out based on size and population density. The latter was adjusted to 1×10^4 to 1×10^5 per ml. These protoplasts were plated on petri dishes containing 0.8% agarose woody plant medium. The concentrations of IAA and kinetin were adjusted to encourage callus proliferation. The next step includes the establishment of totipotent callus in a regeneration medium containing different auxin/cytokinin ratios. The differentiated plantlets could be rooted in a greenhouse medium.

15

BEATTY-DESANA, JEANNE and MICHAEL A. BISHOP. GRC Cytogenetics Section, Clinical Services (GA DHR)-- An unusual inherited fragile site in human chromosomes.

The locations of heritable and constitutive fragile sites have been well described in scientific studies on human and other primate chromosomes. We describe two families in which consistent breaks occur at chromosome 10q24, a breakpoint not described before. It is important to note also that folic acid-free culture medium is not required to demonstrate this fragile site, as it is in other fragile sites described. The two individuals first found to have this 10q24 fragile site were (1) a normal, adult male whose lymphocytes were cultured because he and his wife were having difficulty establishing a successful pregnancy, and (2) a mentally retarded male tested for Fragile X Syndrome. Both were in their late 30-s at test time. Studies of parents were done to establish the inheritance pattern. At the present time there is no reason to believe that this fragile site is linked with a specific phenotype, but may pose an increased reproductive risk for the carrier. Longer term studies could indicate other risks unknown at present.

16

LANGEVIN, SUSAN, A., JAMES B. GRACE, and KEITH CLAY.* Louisiana State University and *Indiana University--Hybridization between red rice and cultivated rice (Oryza sativa L.).

Red rice differs from cultivated rice by having a red pigmented pericarp, a dormancy mechanism, and seeds that shatter readily. When gene flow occurs between red rice and cultivated rice it is in one direction, from cultivated rice into red rice. This is primarily due to the removal of cultivated rice seeds every season through harvest and the shattering of seeds and dormancy that allows red rice to persist in the population. The objective of this study was to demonstrate using electrophoretic markers and morphological characteristics the hybridization between red rice and cultivated rice. Seeds were collected from red rice plants in plots of different cultivated varieties and were grown in a common garden. F_1 hybrids were found to be morphologically distinct from other red rice individuals and exhibited hybrid vigor. Hybrids were taller, had larger leaves, and more flowers per plant. Electrophoretic studies indicated allele differences between red rice and cultivated rice at three loci. These markers were used to confirm the hybrid nature of the F_1 individuals. Synthetic hybrids grown in the greenhouse were also heterozygous at these marker loci. Based on these results, hybridization between red and cultivated rice appears to be common and results in overdominance.

17

KELLER, GWEN P. Savannah River Ecology Laboratory--Electrophoretic detection of hybrid treehoppers (Membracidae) on hybrid oak trees (Quercus).

Within both subgenera of the oak genus Quercus (Lepidobalanus, white oaks; Erythrobalanus, red oaks) hybridization is common. Of the 156 species of treehoppers (Membracidae) of the tribe Smiliinae, 106 are restricted to Quercus. Species of this tribe exhibit varying degrees of host oak specificity, including fidelity to only one host species. Three putative hybrid red oak stands in Michigan, Indiana, and Illinois were studied to elucidate patterns of treehopper colonization on hybrid oaks. These hybrids could possess membracids from either or both parental trees, hybrid treehoppers, or a unique treehopper species. Presumptive hybrid and parental oak stands were morphologically identified, and oak leaves and membracids were collected from all three localities. Insects were identified morphologically and electrophoresed; oak leaves were electrophoresed. Gels were stained for 9 and 11 putative loci for treehoppers and oaks, repectively. Because isoenzymes are under single gene control they can be used as markers to determine the degree of intermediacy of hybrids. Since oaks are long-lived and these treehoppers are univoltine it is possible that colonization of hybrid oaks may result in distinct species arising either from hybrid populations or parental speciation. Preliminary data suggest that these hybrid oak populations may be colonized by treehoppers from both parental oaks with a few hybrid treehoppers as a result of this contact.

18

HOWARD, JAMES H.[1] and RAYMOND P. MORGAN[2] Frostburg State University[1] and Appalachian Environmental Laboratory-University of Maryland[2]--Genetic evidence for stream capture in the central Appalachians

Four pairwise populations of the mottled sculpin, Cottus bairdi, were sampled for electrophoretic analysis. Each pair of populations were collected such that the maximum linear map distance separating the two populations was one kilometer or less. One pair of populations served as a control. Although these headwater populations are in close proximity, no stream capture is hypothesized to have occurred in the control region. The three remaining population pairs all occur in areas where Atlantic-slope drainages are believed to have captured headwaters of Mississippi-slope drainages during the Pleistocene. Because headwater fish populations would be transferred along with the capture, evidence of genetic exchange between adjacent populations should be evident in areas with stream capture. Forty presumptive loci were resolved using standard starch-gel electrophoresis. A minimum of 25 individuals from each of the eight populations were examined. Some genetic differentiation was evident among all populations. However, some population pairs shared rare alleles not present in other populations on either slope. One fixed difference was the maximum between any pairs other than the control. The genetic differentiation between the two control populations was much more extreme, with five fixed differences out of a total of forty loci examined. These results are consistent with the hypothesized areas of stream capture in the central Appalachians.

19

MAYDEN, RICHARD L. AND RONALD H. MATSON. UNIVERSITY OF ALABAMA, TUSCALOOSA -- Preliminary analysis of systematic placement of *Notropis rubellus* (Cyprinidae)

The phylogenetic relationships of *Notropis rubellus* have been controversial for many years. This species has been considered a member of the subgenus *Notropis* by Hubbs and Ortenburger (1929) and Hubbs (1945). Ramsey (1965) and Snelson (1968), however, noted that several morphological characteristics of this species were at variance with other species of *Notropis* (s.s.) and that it may have a closer relationship with the subgenus *Hydrophlox*. More recently, Swift (1970) and Gilbert and Burgess (1980) placed *N. rubellus* in the subgenus *Hydrophlox*. Preliminary analysis of variation of several presumptive gene loci of species of *Notropis* using the methods of starch gel electrophoresis have revealed three informative loci concerning the systematic relationships of *N. rubellus* relative to these two subgenera. At present, no allozyme or isozyme characters have been identified to indicate a close relationship between *N. rubellus* and any member of the subgenus *Hydrophlox*. However, *N. rubellus* did share derived alleles from three loci (Ldh-A, Ak-A, s-Mdh-B) with *N. stilbius*, a member of the subgenus *Notropis*. Three other enzyme systems exhibited potentially informative variation at this level but polarities of these are undetermined at this time. Thus, *N. rubellus* appears to be more closely allied to members of the subgenus *Notropis* than to the subgenus *Hydrophlox*.

20

GRADY, JAMES M., JAMES S. ROGERS, AND ROBERT C. CASHNER. University of New Orleans -- Evolutionary and Biogeographic Relationships of *Fundulus catenatus* (Pisces: Fundulidae)

Genetic affinities of White River, Indiana, and Meramec River, Missouri, populations of the northern studfish, *Fundulus catenatus*, to 19 populations from throughout its range were examined on the basis of allelic distributions at 24 presumptive gene loci. Allozyme data support a close relationship between Indiana and Ozark populations, with the lower Mississippi River population diverging from this lineage. The disjunct population of *F. catenatus* in the Ouachita uplands respresents an early divergence from the Indiana-Ozark-lower Mississippi River lineage. Cumberland, Green, and Tennessee river populations are distantly related to other populations. The pattern of genetic relationships among populations of *F. catenatus* do not support Thomerson's (1969) biogeographical hypotheses and are generally more consistent with predictions based on recent hypotheses concerning the biogeography of the Central Highlands. Genetic relationships indicate a widespread ancestral distribution for *F. catenatus* that subsequently was fractured by a series of vicariant events. The first of these isolated the Cumberland-Green-Tennessee river population. This was followed by dissection of the Interior Highlands, resulting in the isolation of the Ouachita population, with the lower Mississippi River population arising from the Ozark-Indiana population. The close relationship between Indiana and Ozark populations indicates a more recent avenue for gene flow across the Central Lowlands than previously indicated.

21

BRENNEMAN, WILLIAM M. and JOHN V. CONNER. University of Southern Mississippi and Gulf States Utilities Company--Association of lower Mississippi River environments based on relative abundance of fish life history stages.

One hundred eight species were collected from six environments associated with the lower Mississippi River near St. Francisville, Louisiana. Seventy-five of these species occurred as identifiable larvae, juveniles or adults in each of the six environments. UPGMA clustering of Jaccard association coefficients for combined juvenile and adult fishes revealed a single cluster between permanent basin and overflow area floodplain environments. Resolution of distinct (possibly significant) clusters between lower tributary reach and overflow area environments, and between middle and upper tributary reach environments was obtained by clustering Average Distance coefficients which incorporated an additional life history stage (larvae) and the relative abundance of each life history stage into the analysis. For tributary fishes, a substantial increase in number of species represented by larvae occurred between middle and lower reaches, whereas species represented by juveniles and adults showed marked increases between middle and upper tributary reach environments. Analyses of environmental associations based on strict presence/absence of late juvenile and adult fishes may miss important associations determined by shared larval stages.

22

HUNT, TODD D. Tennessee Cooperative Fisheries Unit--Microhabitat of the banded sculpin, *Cottus carolinae*.

Habitat preference of the banded sculpin (*Cottus carolinae*), a benthic dwelling fish, was described in the Caney Fork River of middle Tennessee. Microhabitats were located by underwater observations and physical variables (depth, velocity, substrate and cover) were measured. Habitat availability were determined using PHABSIM for each sampling period and utilization data were transformed into habitat suitability indices for each variable. The exact locations of sculpins were marked and velocities for surrounding habitats were measured a body's length in each direction; upstream, right, downstream, and left, of the fish. Velocities of the precise locations of the fish were shown to be significantly different from left and right velocities, however upstream and downstream flows were not significantly different.

23

KNIGHT, CHARLES L. and ROBERT W. HASTINGS. University of Arkansas, and Southeastern Louisiana University--*Fishes of the Tangipahoa River system in southwest Mississippi and southeast Louisiana.*

The objectives of this study were to compile a list of fish species and to determine distribution patterns of these species in the Tangipahoa River system. This investigation was conducted for an 18-month period and included 85 collections at 59 sites. A total of 11,081 specimens was taken comprising 21 families and 72 species. The family Cyprinidae represented over 50% of the total catch and included 9 species. Centrarchidae followed at 17% of the total with 14 species observed. The most abundant species were *Notropis venustus*, *Notropis roseipinnis*, and *Gambusia affinis*, at 22.60%, 10.25%, and 9.55% of the total catch, respectively. *Lepomis macrochirus* (69.41%), *Lepomis megalotis* (64.71%), and *Gambusia affinis* (60.00%), displayed the greatest percentage frequency of occurrence. Three species collected, *Alosa chrysochloris*, *Heterandria formosa*, and *Etheostoma parvipinne*, were considered new records for the Tangipahoa River system. These species, however, occur in adjacent systems, and were not records for the Lake Pontchartrain drainage. Additional records were located from other sources bringing the total number of species reported to inhabit the Tangipahoa River system to 99.

24

RUDZINSKI, STANLEY and CHRISTOPHER J. O'BARA. Tennessee Technological University--*Fishes of the Barren River system, Tennessee.*

A recent ichthylogical survey of streams within the Barren River system of Tennessee resulted in an increased knowledge of the distribution of rare species. Most notable among these rare fishes were six endemic species to the system. These endemic species include the blackfin sucker, *Moxostoma atripinne*, the teardrop darter, *Etheostoma barbouri*, the splendid darter, *Etheostoma barrenense*, the orangefin darter, *Etheostoma bellum*, and a subspecies of the greenside darter, *Etheostoma blennioides blennioides*. An additional undescribed endemic *Percina* was also collected. The limited distribution of these species in the small streams of this system makes them extremely vulnerable.

25

TIMMONS, TOM J. Murray State University--*Fishes of Murphy's Pond, a cypress swamp in western Kentucky.*

Twenty-seven species of fishes were collected in Murphy's Pond from 1984 to 1986. Seven additional species have been reported from previous collections. The Kentucky distribution of four (*Esox niger*, *Fundulus dispar*, *Lepomis marginatus*, *L. symmetricus*) is restricted to extreme western Kentucky, and one (*Ictalurus nebulosus*) is poorly represented in state collections. Three species from Murphy's Pond have been listed as threatened (*Erimyzon sucetta*) or endangered species in Kentucky (*Fundulus dispar*, *Lepomis marginatus*). The greatest percentage of fish biomass in Murphy's Pond consisted of predators such as *Amia calva*, *Esox niger*, *Micropterus salmoides*, and catfishes (*Ictalurus melas*, *I. natalis*, *I. nebulosus*).

26

BROWN, KENNETH M. Louisiana State University--*Life history trade-offs and optimal offspring size: lack of support from freshwater prosobranch snails.*

I present empirical evidence for whether a trade-off in embryo number vs. mean embryo mass occurs, and whether females in food rich environments produce many small offspring, while those in "bad" environments produce fewer larger offspring. I present data for *Viviparous subpurpureous* and *Campeloma decisum* from Bayou Manchac and Old River. Levels of CPOM were significantly higher at Bayou Manchac (t test, $p<0.01$). There was a 20-fold increase in density of *V. subpurpureus* at the food rich site (t test, $p<0.01$), and a 10-fold increase in density of *C. decisum*, again highly significant (t test, $p<0.01$). The two species differed in number of embryos produced per female ($p=0.04$) but there was a much stronger difference among sites ($p=0.004$) with more offspring produced per female at the food rich site. There was no difference among species ($p=0.23$) but a highly significant difference among sites in embryo size ($p<0.0002$). Both species at the food poor site produced embryos half the mass of those at the food rich site. Finally, for three of the four populations, there were positive correlations between embryo number and mean embryo mass suggesting no obvious trade-off. Thus these results suggest that a clear trade-off between offspring size and number, both within and between sites differing in food levels, does not occur.

27

RICHARDSON, TERRY D. AND JOSEPH F. SIEBENALLER. Louisiana State University--*Levels of aerobic and anaerobic enzyme activities in two populations of the Southern Oyster Drill, Thais haemastoma.*

Two populations of the predaceous gastropod, *T. haemastoma* were sampled and assayed for activity levels of six enzymes. The two populations differed with respect to mean shell size and wave exposure. In foot muscle tissue, phosphofructokinase (PFK), lactate dehydrogenase (LDH), and alanopine dehydrogenase (ADH) were chosen as representative enzymes of anaerobic pathways and citrate synthase (CS) and cytochrome c oxidase (CO) as aerobic enzymes. Malate dehydrogenase (MDH) was also included as it is involved in both pathways. Using size as a covariate, variation among individuals at a site was greater than that between sites for all enzymes assayed ($P>>0.05$) and MDH had the highest activity of all enzymes regardless of site. When the data from each site were pooled, it was seen that foot muscle of T. haemastoma has an anaerobic poise; ADH activity was significantly greater than CS activity ($P<<0.001$). Activity of each enzyme was regressed on whole animal wet weight for size scaling effects. Only PFK showed a significant relationship, with activity increasing with size ($P<0.05$). These patterns of enzyme activity levels in T. haemastoma are consistent with those reported for other invertebrates.

28

TARTER, DONALD, DALE ADKINS, and MARK SHERIDAN. Marshall University--Acid tolerance, under continuous-flow bioassay conditions, and a preliminary study of the effects of chitinolytic activity on iono-regulation in the crayfish Orconectes rusticus.

The crayfish Orconectes rusticus (Girard) was experimentally tested under continuous-flow bioassay conditions to determine its tolerance to low pH. The straight-line graphical interpolation method was employed to determine the pH value at which 50 percent of the crayfish survived after 96 hours. The TL_m^{96} pH value was 3.5. Additionally, a preliminary test indicated that chitinolytic activity increased with decreasing pH. Chitinolytic activity at pH 4.5-5.0 increased two-fold over the control (pH = 7.0-7.5) in the hemolymph but no difference was found in carapace extracts.

29

LASALLE, MARK W. Vicksburg, MS--Leaf mining of the spike-rush Eleocharis parvula (R.&S.) Link by the ephydrid Hydrellia americana Cresson.

The larvae of Hydrellia americana are reported for the first time as leaf miners in the spike-rush Eleocharis parvula. Larvae were collected from patches of Eleocharis in a mesohaline marsh near Wilmington, NC (New Hanover Co.) and an oligohaline marsh near Bay St. Louis, MS (Hancock Co.). Larvae orient along the long axis of the leaf (head toward the tip) and feed from the base of the leaf toward the tip. The larvae feed on the leaf tissue in the center of the cylindrical leaf leaving the outside wall intact. Larvae use their pointed spiracular spines to embed into the root stock of the plant, from which oxygen is obtained for respiration. However, larvae do move freely along the entire length of the leaf as feeding progresses. When feeding is completed in a given leaf, larvae move to another, entering a new leaf by chewing a hole near the leaf base. Three instars are passed prior to pupation which occurs in the leaf. Pupae were observed to be parasitized by an, as yet, unidentified parasitic wasp.

30

NELSON, DIANE R.,[1] DAVID STRAYER,[2] and EILEEN BANNON-O'DONNELL.[2] [1]East Tennessee State University and Institute for Ecosystem Studies, The New York Botanical Garden[2]--Tardigrades from shallow groundwaters in southeastern New York.

Six species of tardigrades were found to inhabit the fresh waters of hyporheic zones, springs, wells, and caves in southeastern New York, including one new species and a member of a genus previously unknown in North America. Tardigrades were scarce at most sites, typically constituting less than 1% of the invertebrate community. However, tardigrades were fairly abundant in springs and in the hyporheic zone of the East Branch of Wappinger Creek. At the latter site, there was a distinct seasonal fluctuation in the abundance of tardigrades, with peak densities and oviposition occurring in the spring.

31

HACKNEY, COURTNEY T. and ROSEMARIE F. GANUCHEAU. University of North Carolina at Wilmington--A new species of Cyathura (Isopoda, Anthuridae) from a high intertidal marsh in North Carolina, U.S.A.

An undescribed species of Cyathura was found in a high intertidal, brackish, Juncus roemerianus marsh in southeastern North Carolina. The new species is morphologically similar to C. polita. It differs strikingly, however, in habitat and with respect to proteins detected by starch gell electrophoresis (electromorphs). The new species is easily separated by its' lack of pigmentation on the antennae. Structural and habitat differences between the three western Atlantic Cyathura species will be discussed.

32

NELSON, DIANE R. East Tennessee State University--Bermuda marine invertebrates.

Bermuda, a crescent-shaped chain of interconnected islands, rests on a mid ocean sea mount about 700 miles off the east coast of the U.S. The Bermuda

Platform rises 14,000 ft. from the abyssal depths of the Atlantic; thus, in the absence of the continental shelf, the deep sea begins offshore. A diverse subtropical marine biota is easily accessible, including mangroves, sea grass beds, coral reefs, intertidal and interstitial communities, rocky and sandy shore organisms, and pelagic nekton and plankton. Marine invertebrates, largely West Indian in origin but with numerous endemics, are the subject of intensive research and summer courses at the Bermuda Biological Station (BBS), an independent international facility. Representative organisms from various habitats were photographed underwater with a Nikonos IVA camera with an SB-101 strobe and close-up lens. A photographic survey of the marine invertebrates will be presented and opportunities for teaching and research will be discussed.

33

SCHOTT, MATTHEW J. (JR.) and DAVID A. WHITE. Loyola University of New Orleans, Louisiana--Morphometric analysis of two adjacent populations of Phragmites australis in the Mississippi River delta.

The Mississippi River delta supports huge monotypic stands of Phragmites australis. Aerial infrared photographs of these stands reveal distinct circular patterns that are consistently observed from year to year. Preliminary ground truthing indicated that the patterns were the result of distinct morphological types. To quantify two of the morphological types, two adjacent populations of Phragmites australis with different signatures were sampled by clipping 20-1 m^2 plots from each population. In the lab a detailed morphometric analysis was conducted on the two samples. The data sets indicate a significant difference in plant height (5.47m vs. 4.32m), plant weight (59.33g vs. 31.83g), leaf weight (7.42g vs. 5.60g), leaf length (66.26cm vs. 63.86cm) and inflorescence weight. Currently we can only speculate as to the reasons for these differences.

34

LUVALL, JEFFREY C. and H. RICHARD HOLBO. Earth Resources Laboratory, National Aeronautics and Space Administration--The use of thermal scanner data in characterizing the thermal response of coniferous forests.

A series of thermal infrared multispectral scanner data (TIMS) was collected over the H.J. Andrews Experimental Forest, a coniferous forest in western Oregon. TIMS flights were timed to coincide with solar noon and about one hour after sundown. Flight lines were overlapped with an 8 to 28 minute time difference between flight lines, and about a 7 hour time difference between the day and night flights. Concurrent radiosonde measurements of atmospheric profiles of air temperature and moisture provided inputs to LOWTRAN6 for atmospheric radiance corrections of the TIMS data. Surface temperature differences over time between flight lines allowed the development of thermal response numbers (TRN) which characterized the thermal response (KJ m^{-2} $^{o}C^{-1}$) of the different surface types. Those containing mostly soil and bare rock had the lowest TRN, whereas the forest-covered types had the highest. The TRN provides a remote measure of the surface's thermal properties, and should provide a valuable quantitative input for global climate modelers. This study provides the basis for future work on comparing the thermal response for a wide range of forest types and ages.

35

MCCORMICK, J. FRANK and WILLIAM H. MARTIN. The University of Tennessee-Knoxville and Eastern Kentucky University--The First Sino-American Ecological Expedition.

Ecological science was relatively dormant in China during the decade of greatest progress elsewhere in the world. Since the cultural revolution (1969-79), China has opened its' doors to western science and technology. Planning for a Sino-American Ecological Expedition began in 1981. Plans were completed in 1983 and the first expedition was conducted in the summer of 1987. Objectives were to evaluate candidate sites for designation as ecosystem reserves; to propose management policies and practices; to identify and prioritize research goals; and to initiate long-term cooperative research. This initial expedition focused upon three areas. Only one met criteria for long-term ecological research and teaching. It is a cluster of three sites (425 ha.) in the Yuntai Mountains of easternmost Jiangsu Province. The principle forest types are: temperate deciduous, pine, bamboo, chestnut, and catalpa-chestnut forests. Because of similarities between temperate forests of the Yuntai and Great Smoky Mountains, the Great Smoky Mountains International Biosphere Reserve was used as a model for development of management and research programs. The three major purposes of the reserve-preservation, research, and education- cannot be satisfied at all three sites because of site conditions and limited area. Therefore, each site will be managed to achieve the single goal for which it is best suited. The Yuntai Ecosystem Reserve has applied for participation in the international network of MAB Biosphere Reserves. This Reserve is one of approximately 250 biological reserves established in China in this decade.

36

MARTIN, WILLIAM H. and J. FRANK MCCORMICK. Eastern Kentucky University and The University of Tennessee-Knoxville--The Yuntai Ecosystem Reserve: Sucheng.

The Yuntai Mountains are located in northeast Jiangsu Province, People's Republic of China. The east-west mountain chain has the highest elevation in the Province (625 m.); bedrock is granitic, and the soils are acidic and coarse-textured. The original vegetation was probably temperate deciduous forest with coniferous forests on the drier, exposed sites. Over the centuries, forest composition has been modified several times. Currently, prevailing forests are extensive Pinus and Castanea plantations. The Yuntai Ecosystem Reserve is a cluster of three sites that have been designated for protection in this decade. One site, Sucheng, will receive special protection as the "core" of the proposed Reserve. It has been chosen because it contains the least disturbed representatives of the plant communities found throughout the Reserve. To initiate a long-term research and monitoring program, permanent plots have been established in each of the plant communities at Sucheng. Compared to southern Appalachian forests, these communities have lower species richness and diversity; general structure is similar to young, successional stands. The most natural forests occur on mesic sites: Catalpa-Castanea communities along the drainages and Quercus-Castanea communities on north-facing slopes. Natural and planted forests on drier, upper and middle slopes are dominated by Castanea mollissima, Pinus densiflora, and Phyllostachys vivax. Management at Sucheng will emphasize preservation and non-destructive research and monitoring. Extensive biological and environmental inventories are planned for Sucheng and the other Reserve sites.

37

Feil, Elisabeth G. University of North Carolina at Charlotte-- Floristics and vegetation of Chimney Rock Park, Rutherford County, North Carolina.

Chimney Rock Park is a portion of the Hickory Nut Gorge, located on the southeastern Blue Ridge escarpment. The vascular flora includes 549 species. Noteworthy are four altitudianl records: Amelanchier sanguinea, Lycopodium selago, Prunus virginiana, Scirpus cespitosus var. callosus occurring between 610 and 762 m elevation. Eighteen community types were analyzed, four minor ones described. Six major vegetation types were recognized: Cove forest, transitional forest, chestnut oak forest, mixed oak forest, pine-oak forest, and pine forest. The vegetation was mapped based on community cover classes. In fourteen of the community types permanent plots were established. Nine soils were identified, two with extremely high base saturations due to the presence of an amphibolite and hornblende gneiss. They support two unusual plant communities: A white ash community with Carex biltmoreana in the herb layer and a hop hornbeam community. Although a literature comparison with other escarpment gorges showed similarities in the major vegetation types, the Hickory Nut Gorge has colder microclimates and less acidic soils. This results in the presence of limestone-loving plant species and unusual plant communities.

38

EDWARDS, M. BOYD. Southeastern Forest Experiment Station -- Floristic Survey of a mid-Georgia Piedmont forest site 1-year after harvest.

The understory vegetative changes that occurred on a clearcut site in the lower Piedmont of Georgia are described at 1 year after harvest. Importance values for the preharvest stand are shown for comparison as well as range in size data for all individual trees 2.54 cm dbh or greater. Eighty-nine species of plants and their frequency of occurrence are documented as first-year pioneers on the site.

39

FRALISH, JAMES S. and FRED B. CROOKS. Southern Illinois University and Center for Field Biology, LBL--Forest communities of the northern portion of Land-Between-The-Lakes, TVA.

Research on the composition and structure of undisturbed, mature forest communities at Land-Between-the-Lakes (LBL) was begun in 1986, under the auspices of the Center for Field Biology-LBL, Austin Peay State University, Clarksville, TN. In the Kentucky or northern portion of LBL, two generally distinct xerophytic communities can be recognized. The first, which occurs on coarse- to fine-textured soil of south slopes, ridges and north slopes is dominated by Q. prinus. Quercus stellata is the major species of the second community which is found on medium- to fine-textured soil of southwest slopes and ridges. Carya glabra, Quercus falcata, Q. marilandica, and Q. coccinea are components of both communities. Xeric-mesic and mesic sites found throughout the landscape generally support communities of Quercus alba but Q. velutina is the major species in some stands. Acer saccharum and other species of mesic sites were found to a minor component of the forest although it appears that they are becoming increasingly important and will replace many oak communities at elevations below approximately 140 m (460 ft.).

40

MOKESH, AMY C.,[1] DAVID L. EDENS,[2] and DAN K. EVANS[1]. Marshall University[1] and West Virginia State College[2]--The bog forest community at Cranberry Glades, West Virginia:II Understory/shrub, herbaceous, and ground strata.

Following an investigation of the arboreal stratum, the lower strata were quantitatively and qualitatively investigated to reveal their respective components. As with the arboreal stratum, many boreal and ecologically equivalent but taxonomically distinct species were found within the lower strata. A number of arboreal species (Tsuga canadensis, Picea rubens, etc.) as well as northern shrub species (Acer spicatum, Viburnum spp.) were found within the understory/shrub stratum, and Rhododendron maximum which formed thickets along the bog-bog forest border. Boreal species found within the herbaceous and ground strata included Lycopodium annotinum, Maianthemum canadense, Listera spp., Hypnum spp., Polytrichum commune, and Sphagnum spp. Within these strata were ecological equivalents, with respect to many other species, with regard to their appearance and significance in more northern bog forests. Also considered was the distribution of these lower strata species with respect to their association with arboreal species and prevailing wind direction.

41

HENRY, BETSY, KENDALL HENRY, DIANNE NELSON, and DONALD TARTER. Putnam County School System, East Tennessee State University and Marshall University --Tardigrade research - secondary school students discover first Tardigrades in West Virginia.

This study is one of many research projects conducted by Betsy Henry's secondary students in Putnam County, West Virginia. Students studied Tardigrade literature and planned the research project. Little Hurricane Creek was selected as the study area. Students numbered zip-lock baggies and mapped the area, and moss samples were collected. Substrata included trees (live and dead), rock and soil. Hydrated mosses were filtered through a screen, funneled into a beaker, allowed to settle, and decanted. Samples were placed in a petri dish and scanned under a dissecting microscope. Sighted Tardigrades were transferred to higher magnification microscopes using an Irwin Loop. We currently use the technique of adding equal amounts of boiling alcohol to live specimens and then scanning and mounting permanent slides using Hoyers medium. This study was conducted in November, 1986, and March, 1987. Tardigrades were positive in mosses Bryandersonia illecebra and Thuidium recognitum on the north side of live oak trees. In October, 1987, tree mosses were negative in this area and Tardigrades were positive in mosses Polytrichum ohioense and Bryandersonia illecebra on soil substrate. The objective of current studies is determination of the number of species in West Virginia and determination if species are substrate specific. Tardigrades keyed were Macrobiotus hufelandi. VCR films of the study and live Tardigrades will be presented.

42

CLARK, ROSS C. The Morton Arboretum--The Chicago Region's Cooperative College Botany Program.

Organismal botany studies have suffered from a long-term decline in the U.S. This trend has been particularly pronounced in smaller liberal arts colleges, who increasingly have been forced to divert limited resources into curricula with high student populations, and to forego curricular areas that serve limited student numbers. Students in many such schools who are interested in botany must either postpone beginning their training until graduate school, transfer to one of the few large institutions that still have viable botany programs, or give up on their interest. Concern about this trend and a conviction that new, broadly-trained botanists are critical to addressing complex environmental issues have stimulated the establishment of a unique partnership in the Chicago, Illinois region. In contrast to other botany partnerships, ours focuses on undergraduates and active secondary teachers. In it, the Arboretum's facilities support classes instructed by Arboretum staff and college faculty members. Students receive credit through any of 15 participating schools. The schools rebate tuition to the Arboretum to run the program. The presentation will cover details of the program's evolution, operation, enrollment, financial status and future plans. We hope that this program provides a model others may wish to emulate.

43

ROWE, MATTHEW and KEN SHULL. Appalachian State University--Mark-recapture using fruit flies: a lab exercise for ecology.

Mark-recapture techniques are used frequently for estimating the size of an animal population. Although simple, these techniques suffer from a number of assumptions which, if unmet, can lead to grossly inaccurate population estimates. Moreover, time restrictions and inclement weather often keep us from teaching these techniques to our students. Using fruit flies (Drosophila melanogaster), we have designed an inexpensive laboratory exercise that overcomes these problems. Fly habitats are constructed from styrofoam boxes and innoculated with wild-type flies. A sample of these flies is captured and replaced with white-eyed flies (the "mark"). Several manipulations provide the students with excellent learning opportunities. For example: (1) students can compare the population estimate derived from a single recapture (Lincoln-Peterson Index) with multiple recaptures (Schnabel Method); (2) assumptions of these techniques can be systematically violated and thus assessed; and (3) population estimates can be compared to the actual population size upon completion of the exercise.

46

STALTER, RICHARD[1] and WILLIAM ODUM[2]. St. John's University[1] and The University of Virginia[2]--Biotic communities of the southeastern United States - maritime communities.

Five regions with maritime communities in the southeastern United States and Gulf coast are recognized: Mid Atlantic Region; Sea Island; Florida Atlantic; Eastern Gulf Coast; Louisiana and Texas. This presentation will include brief information on geology; land use; soils; forests; resource use and management of recreational and commercial resources; the current status of barrier island management; climate; plant succession-community development; sand dune community; shrub community; evergreen maritime forest; shell mound vegetation; salt marsh community; productivity; and fauna.

47

GUNDERSON, LANCE H. and WILLIAM F. LOFTUS. Everglades National Park--Biotic Communities of the Southeastern U.S.: The Everglades.

The Everglades was one of the largest freshwater marsh ecosystems in the world, covering approximately 10,500 km^2 in 1940. Historically, the Everglades was the southern component of a hydrologic system that included the Kissimmee River and Lake Okeechobee. Important environmental factors influencing the plant and animal communities include depth and duration of flooding, fire frequency and intensity, substrate characteristics, hurricanes, and a subtropical climate with occasional freezing temperatures. The spatially dominant, native vegetation community is sawgrass (*Cladium jamaicense*) marsh. Small forests of hardwood species are scattered through the marsh. The open water/spikerush (*Eleocharis celluiosa*) marsh is important aquatic habitat for animals. Although the climate is subtropical, most animals derive from temperate areas. Vertebrate communities are relatively species-poor and exhibit low endemism. Much of the invertebrate fauna is poorly known. Wading birds are the most numerous top-level predators, while fishes are the most abundant vertebrates. The alligator's role in creating open water refugia in the marsh is vital to the ecosystem. Twelve endangered/threatened animals inhabit the Everglades. The historic Everglades is now divided into the following land use types (percent of total historic system): Water Conservation Areas (34%), Agriculture (25%), National Park and/or Preserve (18%), Urban/Developed (13%), and Miscellaneous (10%). Competition for water resources, water pollution, threat of exotic organisms, and conversion of lands to agriculture are major problems threatening the integrity of this once vast wetland ecosystem.

48

STOUT, I. JACK and WAYNE R. MARION. University of Central Florida and University of Florida--Xeric pinelands of the Southeastern Coastal Plain.

Pinelands of the Southeastern Coastal Plain represent fire climax communities whose species reveal a long evolutionary history of adaptation to periodic fires. A lack of periodic fires would, on most sites, allow full expression of southern mixed forests as the regional climatic climax. All of these forests, either pine or hardwood dominated show considerable variation in species composition and structural details over the areal extent of the region. Nonetheless, four pine dominated communities may be identified: 1) pine flatwoods, 2) pine/turkey oak sandhills, 3) sand pine scrub, and 4) pine rockland; a fifth community, palmetto prairies, is restricted to Florida and perhaps best described as "pineless" pine flatwoods. At the regional level, rockland pinelands and sandpine scrub include the least acreage and are the most endangered landscape units.

Animal assemblages associated with the pinelands tend not to be species rich; however, many unique adaptations appear at the level of species and guilds. In general, animal taxon diversity decreases from the coastal plain southward through the Florida peninsula. Endemism is more pronounced within the Florida peninsula than in north Florida and the coastal plain where pinelands serve as refugia for pleistocene relics such as the Florida scrub jay, burrowing owl, gopher tortoise, Florida mouse, and Eastern indigo snake. Guilds associated with fossorial habits are strongly identified with pine/turkey oak sandhills and sandpine scrubs.

49

SHARITZ, REBECCA R.[1], WILLIAM J. MITSCH[2] and LARRY D. HARRIS. Savannah River Ecology Laboratory, Ohio State University, and University of Florida --Southeastern Floodplain Forests

These forests develop in river and stream floodplain areas that are inundated or saturated periodically. Such forests are particularly prevalent in the lower Mississippi River alluvial valley and along many streams that drain the South Atlantic and Gulf Coastal Plains. Through morphological and/or physiological adaptations, the major woody forest species survive, grow to maturity and reproduce in a habitat where the soils in the root zone may become anaerobic for periods during the growing season. Hydroperiod is the ultimate determinant of ecosystem structure and function. Various plant communities are distributed on sites that range from almost continuously flooded (e.g. *Taxodium distichum* - *Nyssa aquatica* swamps) to only intermittently flooded (e.g. forests with *Quercus michauxii*, *Q. nigra*, and *Carya* spp.). The floodplain communities support a rich diversity of plant and animal species. Primary productivity of these ecosystems is generally higher than that of adjacent uplands. It has been estimated that greater than 60% of the original floodplain forests in the Southeast have been lost or severely altered, primarily through draining and clearing for agriculture.

50

DE SELM, H. R. and N. MURDOCK. The University of Tennessee at Knoxville and U. S. Fish and Wildlife Service at Ashville, N. C.--Grasslands and certain other vegetation of the Southeast.
Field reconnaissance, detailed field study and literature have been used to find, describe and interpret ecological relationships of native, natural grassland, grass/sedgeland biota and its woody invaders within the Southeast. Communities which occur on landscapes north of (interior of) the lower Coastal Plain have dominants much like those grasslands of the Middle West. *Spartina pectinata* is rare and *Andropogon gerardii* is unusual as dominants of large areas. *Schizachyrium scoparium* is the usual dominant. Lower Coastal Plain (including north and central Florida) grasslands are wet--generally organized around ponds--or dry--generally occurring as savanna with pine, oak or palm elements. Grassy balds, shale and serpentine barrens are generally unrelated vegetations occurring on special sites.

51

TURNER, ALAN and DONALD TARTER. Marshall University--Influence of brine pollution on benthic populations in three streams of the Pocatalico River, West Virginia.
Physico-chemical conditions and benthic macroinvertebrate community structure were compared among three headwater streams influenced by oil field brines within the Pocatalico River Basin, West Virginia. The River Continuum Concept model was applied to distinguish oil field brine influences from the natural influences acting upon the benthic macroinvertebrate community. Community structure was quantitatively related to the physico-chemical conditions by analysis of variance and Ecological Community Analysis. Salinity was characteristically unique for each stream, from highly saline or brackish water at McKown Creek, to moderately saline water at Johnson Creek, to fresh water at Flat Fork. Flow acted in conjunction with salinity to maintain low density populations within the saline streams. Reduced abundance without a corresponding change in richness created diversities within high and moderate salinities that equaled or exceeded those within fresh water. Hemimetabolous insects with well developed or protected tracheal gills replaced insects without gills within moderate salinities. Holometabolous insects replaced hemimetabolous insects within high salinities. Within extreme salinity, richness and diversity was presumed to become reduced when replacement species became exhausted from the stream. Structural and functional characteristics of the stream communities appeared to be conserved through the replacement of brine-intolerant forms with brine-tolerant forms as long as replacement species existed within the streams. The Ecological Community Analysis identified a predominance of burrowing invertebrates, mainly oligochaetes, existing within the saline streams.

52

PRICE, GREGORY and MARY U. CONNELL. Appalachian State University--Benthic algal community structure changes associated with nutrient loading and stream recovery in the South Fork of the New River.
Benthic algal community changes associated with nutrient loading and stream recovery were examined in a stretch of the South Fork of the New River where this shallow mountain stream receives the effluent from the Boone Sewage Treatment plant. One upstream and five downstream collecting sites were used to compare the differences in water chemistry and algal community composition and structure. Results of water analyses indicated that the river was receiving significant quantities of inorganic nutrients in the form of ammonia nitrogen and orthophosphate. Nutrient concentrations of the stream decreased with the linear distance from the sewage outfall, however, nutrient concentrations at the downstream sites were always higher than the control site. Benthic algal community structure and composition were also different in the enriched sections of the stream with the greatest difference seen at the first downstream site. Species diversity and standing crop biomass fluctuated seasonally. However, results indicated that the benthic algal community at the downstream sites experienced a decrease in species diversity that corresponded to the increase in nutrient concentrations. The control site community was dominated by diatoms while the downstream site with the highest nutrient contrations had a diatom frequency of less than 1%.

53

KOKESH, AMY and DONALD TARTER. Marshall University--Effects of acid-buffering capacity on the seasonal diversity and distribution of benthic populations in the Cranberry River, a naturally acidic watershed in West Virginia.
The chemical water quality of the Cranberry River declines gradually from the headwaters to the tailwaters. Most tributaries originate in the Pennsylvanian Pottsville sandstones which contribute little to acid-buffering capacity. However, the South

Fork flows entirely over the Mississippian Mauch Chuck shales that are calcareous and provide some acid-buffering capacity. Benthic populations from four headwater tributaries of the South Fork ($\bar{X}$, pH = 7.05) were used to evaluate the effects of acid-buffering capacity on seasonal diversity and distribution. The following components will be discussed and compared to benthic populations from the Cranberry River underlain by Pottsville sandstones ($\bar{X}$, pH = 5.45): number of taxa, percentage composition, species diversity, and functional groups (shredders, collectors, scrapers/grazers, predators).

54

TAYLOR, BARBARA E., DIANE L. MAHONEY, and ADRIENNE E. DEBIASE, Savannah River Ecology Laboratory--*Communities under stress: zooplankton dynamics in two cooling reservoirs*.

Pond C and L Lake are cooling reservoirs for nuclear reactors on the Savannah River Plant in South Carolina. Although thermal discharges to the two systems are similar, differences in sizes and shapes of the reservoirs result in different thermal regimes. Pond C, the more extreme system thermally, was usually dominated by the rotifer *Filinia longiseta*. Dynamics of the zooplankton in the main channel was a series of episodes of extinction and recolonization. Species composition was strongly influenced by refuge populations and by the duration of reactor outages. In L Lake, which is larger, thermal effects were less severe. A fairly diverse community was maintained, and it was often dominated by crustaceans such as the copepod *Diaotomus dorsalis*. Trophic interactions appeared to have more influence on this community.

55

MCKAY, GREG and DONALD TARTER. Marshall University--*A preliminary study of the effects of artificial lake destratification on fish populations in Beech Fork Lake, West Virginia*.

Artificial destratification of Beech Fork Lake, West Virginia, was initiated in May 1987 when four artificial destratification fans were installed by personnel from the Huntington District of the U. S. Army Corps of Engineers. Improved water quality and productivity are desirable results of artificial lake destratification. Fish populations within the 291 ha impoundment were sampled monthly through October. The scale method of age and growth determination of fishes was used to establish baseline data for comparison in future studies. The stomach contents were analyzed and correlated with available food. Further research is expected to reveal an increased rate of growth of the fishes as lake productivity increases and modification of their diet as the community structure of organisms at lower trophic levels is altered in response to artificial lake destratification.

56

BREWER, J. STEPHEN and JAMES B. GRACE. Louisiana State University--*Vegetation dynamics of an oligohaline tidal marsh*.

Spatial and temporal patterns of plant species distributions were examined in an oligohaline tidal marsh located along the Tchefuncta River adjacent to the north shore of Lake Pontchartrain in Louisiana. Three perennial species, *Cladium jamaicense* Crantz, *Sagittaria falcata* Pursh., and *Spartina patens* (Aiton) Muhl., representative of fresh, oligohaline, and brackish marshes respectively, are oriented along what appears to be a gradient of increasing salinity toward the lake shore. Although a salinity gradient is seen in the adjacent estuary, salinity patterns within the marsh are more complex. Portions of the marsh which are partially impounded exhibit elevated soil salinities. *C. jamaicense* and *S. patens* exhibit dominance throughout the year, whereas *S. falcata* is replaced in the fall by annual species such as *Aster subulatus* Michaux, *Echinochloa crusgalli* (L.) Beauvois, and *Leptochloa fascicularis* (Lam.) Gray. Community patterns in this tidal marsh appear to be influenced by a complex of environmental factors, such as salinity and the hydrologic regime, as well as the life histories of the component plant species.

57

ROZAS, LAWRENCE P.,[1] CAROLE C. MCIVOR,[2] and WILLIAM E. ODUM.[3] Waterways Experiment Station[1], MBL, Woods Hole[2], and University of Virginia[3]--*Intertidal rivulets and creekbanks: corridors between tidal creeks and marshes*.

We sampled rivulets and creekbanks with flume nets between June and October 1986 to determine whether fishes preferentially use rivulets to reach the marsh surface. The average number of fishes collected in rivulets was more than three times that taken on creekbanks. Similarly, average total fish biomass was more than 14 times greater in rivulets. By estimating the abundance of rivulets, depositional creekbanks, and erosional creekbanks in our study area, we determined the relative importance of each of these three corridors. We estimated that rivulets occupied only 3% of the area along our study creeks. Therefore, despite a preference for rivulets as corridors, most fishes (88%) reach the marsh surface via creekbanks. Depositional creekbanks are the primary corridors between tidal creeks and the marsh surface.

58

SHAFFER, GARY P., Louisiana State University--*K-systems analysis for determining the factors influencing benthic microfloral productivity in a Louisiana estuary, USA*

About 3000 sediment cores from Barataria Estuary, LA were incubated between July 26 and August 25, 1983. Other variables monitored were chlorophyll a, light intensity, water temperature, salinity, benthic community respiration, productivity of the water column, biological activity (muddy sand site), wave height (sand site), meteorological tides (wind induced water levels), tide height, and initial dissolved oxygen. K-systems analysis indicated that the environmental variables acted in combination to influence productivity, and that the combinations changed through time. Physical processes (meteorologic, astronomic, and anthropogenic) largely controlled productivity at the sand site. Productivity at the muddy sand site was influenced by a combination of physical and biological activities.

59

SHAFFER, GARY P., Louisiana State University--A comparison of benthic microfloral production on the west and gulf coasts of the United States: an introduction to the dynamic K-systems model.

Intensive month-long studies of benthic microfloral productivity were conducted during the summer in California (Mugu Lagoon) and Louisiana (Barataria Estuary) coastal wetland ecosystems. Collectively, productivity was controlled primarily by different types of disturbance: tidal currents, meteorological and man-made waves, and direct and indirect disturbance by macrofauna were most important. To explore the potential of K-systems analysis as a modeling tool, simple models restricted to physical variables were developed for each site. These models suggested that certain variables such as tidal currents and waves functioned primarily as controllers (e.g., acted to decrease productivity), while others such as light and temperature functioned as modifiers (e.g., modified the severity of the decrease). The effects of modifying variables are highly consistent, granted interrelationships with other variables are considered. If modifying variables are isolated (as in parametric statistics) their effects appear spurious. In general, the K-systems models suggested that dynamic behavior simply cannot be captured with a static model.

60

HUBBS, DONALD W. Tennessee Technological University--Assessment of spawning habitat of Lake trout Salvelinus namaycush and Muskellunge Esox masquinongy in Dale Hollow Lake.

Lake trout Salvelinus namaycush were first introduced into Dale Hollow Lake in December of 1977. An ARC/INFO geographic information system (GIS) was used to link a digitized map of the lake to dissolved oxygen and temperature profiles of the lake. A model was developed which estimated suitable spawning habitat as areas with a temperature ≤11 C (52 F) and dissolved oxygen content ≥5mg/1. A spawning habitat model was also developed for muskellunge Esox masquinongy. This model defined spawning habitat as areas with a depth ≤2 meters, temperature of 14-16 C (57-61 F), dissolved oxygen content ≥5mg/1, and presence of aquatic macrophytes. The GIS selected the polygons within the lake which met these criteria and produced maps displaying the spawning areas for lake trout and muskellunge. The total area (in square meters) of these polygons is considered to be the amount of habitat in which lake trout and muskellunge would achieve the greatest reproductive success.

61

BAKER, JOHN A. and DAVID C. HEINS. US Army Engineer Waterways Experiment Station, and Tulane University--Reproductive biology of Noturus hildebrandi in the Homochitto River, Mississippi.

Mature females of the least madtom were collected from mid-March to early September 1985 in the Homochitto River, southwest Mississippi. Early in the season only females over 35 mm SL were mature, although even in fish as small as 27 mm SL ovaries were beginning to enlarge. By mid-April 60% of all females were mature and had large, orange mature oocytes. In May all females were reproductive, having mature or ripe ova. Clutches contained from 28-61 mature oocytes in females 37-44 mm SL, and clutch size increased with female size. Mature oocytes ranged from 2.25-2.75 mm diameter. It appears that females all reproduce at one year of age; and it is likely that few, if any, live long enough to reproduce in subsequent years. Although not yet firmly established, it is possible that the early spawning females may produce a second clutch later in the year. This population of N. hildebrandi differs in several reproductive traits from those in the northern part of its range, in western Tennessee. The breeding season is considerably longer, and in fact appears to be the longest for any Noturus. Clutch sizes for females of comparable length are also larger, and females appear to mature at a slightly smaller size.

62

KNIGHT, JEREMY G. University Of Southern Mississippi--Reproductive biology of the bayou darter, Etheostoma rubrum. The bayou darter, one of the more diminutive species of the subgenus Nothonotus, is endemic to the Bayou Pierre system in southwestern Mississippi. Because of its limited distribution and habitat alterations it is listed as endangered in Mississippi and federally threatened. I studied reproductive biology from March, 1986 to March, 1987 using monthly collections taken from various localities. Sex can be determined visually in adults based on coloration patterns, however, juveniles cannot be readily sexed in the field. Reproductive data included the stage of development, mean ova diameters and ova numbers. A gonadosomatic index (GSI) was used to estimate reproductive readiness. Ovaries contained eggs in three distinct size classes which may be spawned group synchronously. Mean GSI's indicated that the bayou darter spawns from April through June, the peak being in May. Mean fecundity from one reproductive season is 103+/-46 for three size classes as taken from females in early, late and mature stages of development. However, because the frequency of spawning cannot be determined from ovarian analysis, this estimate may be conservative. Fecundity in the bayou darter is within the range of estimates made for two other species of Nothonotus based on mature, or mature and immature ova respectively.

63

MEFFE, GARY K. and DAVID L. CERTAIN. Savannah River Ecology Laboratory and The University of Oklahoma--Selective mortality of post-spawning yellowfin shiners (Notropis lutipinnis).

We collected a series of dead yellowfin shiners in summer 1986 from a headwater stream of the Savannah River drainage, South Carolina. Because the fish appeared to be emaciated post-spawners, we hypothesized that death was a function of weakened condition due to the high energetic demands of spawning. We tested that hypothesis by comparing somatic weight, visceral fat content, stomach contents and gonad weight of dead fish to a series of live fish collected in the same area at the same time. All characteristics in males indicated that dead fish had spawned and were in worse physical condition than live fish. Somatic, but not reproductive characteristics in females also supported the hypothesis. We conclude that fish died largely as a result of poor physical condition following spawning; however, we do not know the proximal cause of death. We also do not know if this is a regular occurrence in yellowfin shiners, nor its importance to stream community dynamics.

64

DOMINEY, WALLACE J. Mississippi State University--Mating tactics in bluegill sunfish.

Bluegill sunfish males practice several alternative mating tactics. These tactics include the typical nesting behavior shown by most male centrarchid fishes, as well as 1) "sneak" male behavior in which some males rush into nests to spawn along with spawning pairs, and 2) "female mimicry" where some males gain access to nests by mimicking the behavior of females. Female mimics (small) and nesting males (large) have disjunct size distributions and yet have the same age distribution. "Sneak" males are shown to be the early ontogenetic stage of female mimics. An F1 cross was conducted to determine the heritability of these mating tactics with negative results. The ontogeny and evolutionary consequences of these mating tactics are considered.

65

BORTONE, Stephen A.[1] and William P. DAVIS[2]. University of West Florida[1] and U. S. Environmental Protection Agency, Gulf Breeze, FL.--Environmentally Masculinized Mosquitofish as a Naturally Occurring Bioassay.

Environmentally induced masculinization (arrhenoidy) is known to occur among female mosquitofish inhabiting streams receiving paper-kraft mill effluent (KME). Previous studies have shown that there is a correlation between the degree of masculinization and proximity to the effluent source. To determine if naturally occurring mosquitofish could be used as a way of assessing the potential impact that this effluent might have on aquatic systems, a survey was conducted on several morphological and behavioral characters associated with non-effluent and effluent receiving mosquitofish. A discriminant function analysis of 14 morphometric characters could be reduced to 9 characters and permit correct sex/effluent group assignment in 95.3% of all cases. An analysis of reproductive behavior indicated significant differences in behavior between sexes but no differences between effluent groups. Morphometric character analysis may be useful as a natural bioassay in assessing the impact of KME on aquatic habitats. A behavioral bioassay, using the reproductive behavior among mosquitofish, would not be as effective based on our experimental design.

66

CODY, RICHARD P. University of West Florida--Evidence of hermaphroditism in the littlehead porgy, Calamus proridens.

Among the family Sparidae, the diversity of hermaphroditic expression is unrivaled by any of the other perciforms with the possible exception of the serranids. Hermaphroditism of one type or another has been observed in over 20 sparid species. The littlehead porgy Calamus proridens, is a demersal sparid inhabiting the coastal waters of Florida, Cuba and the Campeche Bank, Mexico to depths of atleast 55 m. Gross gonadal examination of a collection of 17 specimens revealed a predominantly female composition. Gonadal tissue of one specimen was shown to contain ovarian and testicular portions as determined by both gross and, histological investigation of structure. Morphological patterns of intersexuality observed showed similarities to other sparids. The significance of "patterns of sexuality" as a factor in determining phyllogenetic relationships among related species has been assessed by authors for other families. Sexuality may also serve as an effective parameter for classification of porgies with further description of sexual patterns of more species.

67

CODY, RICHARD P. University of West Florida--Sex expression in the pinfish, Lagodon rhomboides.

The pinfish is one of the most abundant members of the sparid family ranging from the Yucatan peninsula, Mexico to the Cape Cod region of the United States. The vast numbers of pinfish occupying inshore and estuarine habitats suggest an ecological role or impact of significance It is of major importance as a forage fish for commercial species and also as a predator of seagrass epifauna. A total of 975 specimens ranging in size from 50mm - 280mm S.L were found to consist of 304 females, 233 males and, 432 undetermined based on gross morphological appearance of the gonad. Length frequency analysis revealed no significant differences in size composition between males and females. A functional discrimination analysis performed for 63 individuals on 21 body characteristic measurements revealed the absence of any obvious sexual dimorphism. Ovarian and testicular tissue development was traced on a monthly basis and the validity of sex already determined by gross gonadal examination confirmed by histological investigation of a subsample of 72 specimens. No evidence of sex reversal was found.

68

ZIESKE, GLEN G. Louisiana Department of Wildlife and Fisheries--Redescription of larvae of the pinfish, Lagodon rhomboides Linnaeus (PISCES, SPARIDAE).

Larval development of the pinfish, Lagodon rhomboides, was first described by Hildebrand and Cable (1938) based on larvae collected near Beaufort, N.C. Larvae and juveniles ranging from 5.0mm to 40.0mm SL were described; however as few as one specimen for some length ranges were available and they totally lacked specimens for other ranges. This redescription is based on specimens collected off the central coast of Louisiana in the northern Gulf of Mexico between November 1982 and May 1984. Larvae ranging from 3.3mm to 13.9mm SL were used for this study, with five specimens from each range examined for morphometrics and pigmentation. It is thought that pinfish spawn offshore, and then the larvae move inshore between the months of October and March (Ditty 1986). This study showed pigmentation patterns not mentioned in previously published literature. Fin development begins at 4.3mm SL and is complete by 12.7mm SL. Juvenile stage is reached by 13.9mm SL, with pigmentation resembling that of the adult. Collections were made by the Louisiana Department of Wildlife and Fisheries environmental monitoring project of the Louisiana Offshore Oil Port, and by the South East Area Monitoring and Assessment Program (SEAMAP).

69

KUHAJDA, BERNARD R. University of Alabama, Tuscaloosa--Use of museum specimens for examining spermatozoan morphology of North American Cyprinidae genera.

Museum specimens are a convenient source of spermatozoa. I examined 1514 spermatozoa from 95 museum specimens of 16 species of North American Cyprinidae in 13 genera. Spermatozoa were measured under light and scanning electron microscopy. Tissue degeneration was present in most of the material examined. The method employed in removing the spermatozoa from the testes caused additional damage, including broken flagella. Scanning electron microscopy revealed spermatozoa possess a round head with no acrosome, an asymmetrical post-nuclear midpiece (cytoplasm with mitochondria), and a single flagellum (tail). The relationships among the cyprinids examined inferred from spermatozoan dimensions varied according to which microscope was used in collecting data and which dimensions were compared. Thus, only limited data were available from museum specimens. Using fresh spermatozoa should allow for a more detailed comparative examination of spermatozoan features, including using transmission electron microscopy to examine subcellular structures.

70

MULLER, ROBERT N.,[1] PAUL J. KALISZ,[1] and JAMES O. LUKEN.[2] University of Kentucky[1] and Northern Kentucky University[2]--Production of astringent phenolics in fine roots over a vegetation-resource availability gradient.

Fine roots (<1mm diameter) were examined over a gradient of species composition in the Mixed Mesophytic Forest Region to test the hypothesis that quality of this ephemeral tissue declines as species composition changes over a gradient of decreasing nutrient availability. Concentrations of calcium, nitrogen, and phosphorus in root tissue declined by 48, 36, and 74%, respectively, over a gradient that incorporated a soil pH range of 6.4 to 4.3. Lignin was unrelated to either the vegetation gradient or any of the soil changes it encompassed. Astringent phenolics increased by 273% over the same gradient. This response is best related to changes in species composition. However, astringent phenolics were also well-correlated (negatively) with nutrient content of fine roots as well as indices of availability of those nutrients in the 0-5 cm depth of the mineral soil. Site fertility is likely an important factor in determining production of root phenolics. The patterns of this study follow those observed previously in foliage, another ephemeral tissue, and suggest even more strongly that production of phenolics is increased on nutrient-poor sites.

71

HULL, JAMES C. and SARAH G. WOOD. Towson State University--*Soil nutrients and the distribution of oaks on serpentine soils in Maryland.*

The distribution of oaks on and off serpentine soils was examined with respect to soil chemistry. Available forms of Ca, Mg, Ni, Cr, K, and P were extracted from serpentine and non-serpentine soils, and the same elements were analyzed in tissues of oaks collected at the sites. *Quercus alba* and *Q. velutina* grew on non-serpentine soils, while *Q. marilandica* and *Q. stellata* grew on serpentine soils. There were no significant differences between soils or tissues for K, P, Ca, Ni, or Cr. Serpentine soils had significantly greater Mg contents, however there were no significant differences between oaks in tissue Mg content. The Ca/Mg ratios of serpentine sites were significantly lower than non-serpentine sites. Accumulation ratios (the ratio of elemental tissue to elemental soil content) of Mg were significantly greater in the non-serpentine sites than in serpentine sites. The Ca/Mg accumulation was significantly greater at serpentine sites. These data support a hypothesis of selective accumulation of Ca and Mg by serpentine species.

72

WARE, STEWART. College of William and Mary--*Adaptation to substrate--and lack of it--in rock outcrop plants.*

The calcareous rock outcrop "cedar glades" of middle Tennessee are well known for their endemic plant species. However, *Arenaria patula* Michx. (Caryophyllaceae) and *Sedum pulchellum* Michx. (Crassulaceae), two shallow soil dominants, are not endemics. Both are abundant on calcareous, sandstone, shale, and chert outcrops in the Ozarks and Ouachitas. To test whether these species achieve broad substrate distribution by broad ecological tolerance for soil type or by ecotypic adaptation, plants of each species from various outcrop types were grown in the greenhouse on their own native soils and on alien soils from other substrates. *Arenaria patula* showed clear ecotypic adaptation to soils among its various populations. Tennessee plants grew much better on their native limestone than on the sandstone or granite soils. In contrast, the Ozarks sandstone population grew well on sandstone, poorly on granite, and very poorly on limestone. Ozark limestone plants grew equally well on sandstone and on limestone, but poorly on granite. All *Sedum pulchellum* populations, regardless of origin, grew well on limestone soil and poorly on sandstone, shale, granite, and dolomite. Thus, populations from sandstone and shale grew much better on the alien limestone than on their native sandstone and shale, showing no adaptation to these latter two substrates. Despite the similarity in chemistry and pH of dolomite and limestone, both Ozark and Tennessee limestone populations were greatly inhibited by dolomitic soil.

73

GIBSON, JOAN R. University of North Carolina--*Relationship of Vegetation to diabase dikes and sills of the Gettysburg basin, Pennsylvania.*

Igneous, quartz-normative diabase occurs as dikes and sills in association with the Gettysburg Mesozoic basin in the Piedmont of southcentral Pennsylvania. Vertically emplaced dikes form relatively narrow, well-fractured, rocky ridges, whereas horizontally emplaced, thick sills with their massive outcrops form most of the hills on the Gettysburg Plain. The relatively unfractured sills provide little water storage, but may impede drainage. Within the study area, diabase occurs as two chemically distinct populations: York Haven (extensive sill) and Rossville (sill and the Gettysburg-Duncannon dike). Fifty-eight stands were sampled in 15 x 25 m plots on dike, sills, and non-diabase comparison areas. Although importance values were determined for herbs, shrubs, and trees, this paper deals primarily with tree species distribution. Soils were analyzed both in the field and laboratory. Ordinations (using Detrended Correspondence Analysis) were performed on the vegetation data and statistical analyses on the environmental data with the ordination scores. Canopy vegetation was dominated by various oaks and *Liriodendron*. White oak showed preference for sills; red oak for Rossville sill; black oak for Rossville dike; and *Liriodendron* for York Haven sill. Both the field observations and ordination procedures indicated that moisture, as affected by the topography, geology, and soils, was the significant controlling factor relating to vegetation distribution on diabase.

74

GRELLER, A.M.[1], I.A.U.N. GUNATILLEKE[2], A. H.M. JAYASURIYA[2], S. BALASUBRAMANIAM[2], C. V.S.[2], S. WIJESUNDRARA[2], AND M.D. DASSANAyake[2] Queens College CUNY[1], and University of Peradeniya, Sri Lanka[2]--*Trends in Generic Dominance of Montane Forests Along a Moisture Gradient in Sri Lanka.*

We compare tree canopy composition in the montane zones of the Knuckles Range, Pidurutalagala Range, and Peak Wilderness Range. On Hakgala Peak, Pidurutalagala Range, our driest site, montane forests are dominated by *Psychotria*, *Hedyotis*, and *Osbeckia*. In the Knuckles Range, montane forests are dominated by two species of *Calophyllum* and by *Garcinia echinocarpa* (both in the family Clusiaceae). In the very wet Peak Wilderness Range, one of three species of *Stemonoporous* (endemic, Dipterocarpaceae) dominates each of our stands. *Palaquium rubiginosum* (Sapotaceae) codominates in two of these stands; *Cinnamomum ovalifolium* (Lauraceae) is the only other dominant taxon.

75

WU, XINYUAN and J. FRANK MCCORMICK. University of Tennessee--Growth patterns of red spruce populations in two spruce-fir forest stands in the Great Smoky Mountains National Park.

This study was conducted to describe the patterns of growth by which young red spruce trees reach the canopy; and to compare the growth pattern of the canopy population with that of the noncanopy population, which reflects differences between the historical growth pattern and the contemporary growth pattern of red spruce population. Increment cores were extracted from canopy and noncanopy trees in two stands along Noland Divide Trail in the Great Smoky Mountains National Park. Each tree ring series was devided into a sequence of suppression and release periods. The growth patterns of red spruce populations were described using four parameters: number, duration, average annual increment of radial growth and cumulative annual increment of radial growth of suppression/release periods. Analysis on overall population growth was also conducted. Results reveal the following: 1) The red spruce population experienced an average of 2.07 suppression periods which averaged 18.6 years duration. The average annual increment of radial growth in suppression periods is 0.267 mm and the cumulative annual increment of radial growth is 4.98 mm. 2) The growth pattern of the red spruce population in stand I on a south facing slope is not significantly different from that in stand II on a north facing slope. 3) There are more suppression periods in the growth pattern of the noncanopy population than that of the canopy population. Trees in non-canopy population grow slower in release periods than trees in canopy population. 4) Trees grow faster in the direction perpendicular to the contour (uphill side) than in the direction parallel to the contour.

76

STALTER, RICHARD[1], KINCAID, DWIGHT[2] and ERIC LAMONT[3]. St. John's University[1], Lehman College, CUNY[2], and The New York Botanic Garden[3]--Life forms and water relations of vegetation, Hempstead Plains, New York.

The flora of Hempstead Plains, Long Island, New York, was sampled on a weekly basis from April 15, 1986 to October 15, 1986. One hundred seventy one taxa were identified. These were arranged in a Raunkiaer Life form spectrum. Xylem water potentials for 94 taxa from Mitchell Field were measured using a Scholander-type pressure chamber on 12 mid-days from May 1986 through May 1987 (N = 1195). The frequency distribution of water potentials was highly statistically significant for positive skewness and for leptokurtosis. Phanerophytes such as Quercus coccinea and chameaphytes e.g. Rubus flagellaris developed low water potentials in winter although this pattern was not universal for all Raunkiaer categories. Cryptophytes and hemicryptophytes had an extremely wide range of water potential during spring drought. Strategies such as underground protection of meristematic tissue linked to variations in the seasonality of growth, and combined with differential water relations, may assist in the extraction of soil water and allow survival and growth during drought induced water stress. Our results on the highly variable nature of water status, suggest a partitioning of the habitat, perhaps assisting in the packing of 171 species within the 8 ha remnant of prairie at Hempstead Plains.

77

HUPP, CLIFF R., WILLIAM P. CAREY, and DAVID E. BAZEMORE. U.S. Geological Survey, Nashville, Tennessee--Tree growth and species patterns in relation to wetland sedimentation along a reach of the Middle Fork Forked Deer River, West Tennessee.

Sedimentation affects numerous aspects of wetland ecology. Many riverine wetlands, wooded swamps, in the Gulf Coastal Plain have experienced accelerated sedimentation and protracted hydroperiods from erosion of agricultural uplands, and construction of levees and highway embankments. The USGS has begun a study along the Middle Fork Forked Deer River to analyze and interpret historic and recent amounts and rates of sedimentation and its effect on wetland-forest growth. This cypress-tupelo swamp is analyzed through dendrochronological, plant-ecological, and sedimentological methods. About 125 trees havebeen sampled for tree-ring analysis, age, and growth response, and were excavated to their root collar to determine amount and rate of burial. Plot-analysis data and species- presence data were collected along transects to determine species patterns, and forest composition and structure. Artificial substrates and single-stage sediment samplers were installed at sites within the swamp to analyze sediment loads during the hydroperiod; these data are combined with gaging-station records to interpret annual sediment budgets and routing within the swamp. Preliminary results suggest that levee construction has affected the sedimentation rates and flow patterns upstream of its location. Bald cypress, bottomland oaks, and green ash show a distinct reduction in growth rate that coincides with levee wconstruction. Tupelo shows little reduction in growth rate and appears to proliferate in areas subjected to high sedimentation rates and protracted hydroperiods. Dendroecological analyses hold promise as useful techniques to estimate and interpret trends in wetland sedimentation and forest ecological responses.

78

RAY, DARRELL L. and JOE E. WINSTEAD. Western Kentucky University --Shortleaf pine as a monitor of sulfur deposition patterns on the Cumberland Plateau in Kentucky.

Analysis of stem wood from Pinus echinata Mill. for elemental sulfur indicates increasing levels of SOx exposure in the forest ecosystems on the Cumberland Plateau. In wood formed during thee years 1962-65 sulfur levels ranged from 0.03 to 0.06 mg S/g dry wt in populations from both northern and southern extremes of the plateua. Extractions of growth increments formed in the 1982-86 years indicate increase of sulfur ranging from 0.06 to 0.11 mg S/g dry wt. A centrally located population of this species had consistently higher levels of sulfur incorporated into growth rings compared to the values obtained from the other sites. Such increased levels may indicate greater localized SOx loads than regional averages. Deposition of sulfur from atmospheric pollution and subsequent incorporation into tissues of forest species appears to be widespread and not limited to shortleaf pine. While the levels of sulfur incorporated into woody tissue may or may not be a limiting factor in growth physiology, interesting questions remain concerning the quality of wood products manufactured from forest species exposed to increased levels of domestic and industrial air pollution.

79

WINSTEAD, JOE E. Western Kentucky University --Sulfur content of wood in sweetgum and ironwood from the central United States: changes after 12 years.

Sulfur in wood of both *Carpinus caroliniana* Walt. and *Liquidambar styraciflua* L. showed increases since the early 1970's to levels as much as five times greater in 1986. Wood of Alabama populations of blue beech or ironwood had lower levels of sulfur than Michigan trees of this species sampled in 1972 but by 1986 had increased to levels double that of the more northern collection sites. Mid-latitude Kentucky sweetgum trees showed 0.12 mg S/gm dry wt of wood representing 1982-87 growth compared to 0.07 mg S/gm in xylem formed a decade earlier. The increases of sulfur in secondary xylem over the past decade or more parallels the increases of anthropogenic sulfur deposition on the central United States' biota and the shifts of elemental sulfur in the atmosphere toward the more southern regions of this country in recent years.

80

GRACE, JAMES B., DIANA STELLER, GLENN GUNTENSPERGEN, and JANET KEOUGH. Louisiana State Univ.--The relationship between salt tolerance and competitive ability in wetland plants.

Previous studies have suggested that an inverse relationship exists between stress tolerance and competitive ability for wetland plants. Our objective in this study was to examine competition for nutrients between a salt tolerant species, *Spartina patens* and an intolerant species *Scirpus validus*. In addition to this main objective, we also wished to determine the nutrient use relationships of the species and the effects of density on competitive outcome. Transplants of both species were grown in monoculture and mixture in the greenhouse using natural sediment. Nutrient use characteristics were determined by growing the plants in various mixtures of sand and sediment. Competition experiments were conducted at three densities. The salt intolerant species, *Scirpus validus*, was found to be the superior competitor regardless of initial density. *Scirpus* was also found to have a higher growth rate at ambient levels of nutrients though the species did not differ in growth rate at reduced nutrient levels. Overall, these results are consistent with the hypothesis that stress tolerance is inversely correlated with competitive ability. Further, the data indicate that salt tolerance may lower competitive ability by interfering with the species' growth potential.

81

VISSER, JENNEKE M. Louisiana State University--Production of two Sagittaria species in a developing delta, Atchafalaya Bay, Louisiana.

Sagittaria latifolia and *Sagittaria platyphylla* are plant species that provide an important food source for large numbers of waterfowl and furbearers in the Atchafalaya Delta. Above and below ground production of both species was measured during the 1986 and 1987 growing seasons. Above ground production was estimated by sequentially harvesting 1/4 m^2 plots, and non-destructively from stem density using an experimentally derived relationship between leaf length and biomass. Below ground production was estimated from root and tuber biomass in cores taken at the beginning and at the end of each growing season.

82

DAY, FRANK P. and J. PATRICK MEGONIGAL. Old Dominion University and Savannah River Ecology Laboratory--Hydroperiod effects on biomass allocation and root distribution in cypress mesocosms.

Large experimental mesocosms are being used to investigate the effects of continuous flooding (CF) versus periodic flooding (PF) on allocation of production and spacial distribution of roots of cypress in organic soils. After the first growing season, substantial growth had occurred in both treatments. The slower growing CF seedlings doubled in height and increased in total biomass by a factor of 22 X. The PF seedlings tripled in height and produced about 3 times more mass aboveground and belowground than the CF seedlings. The top 20 cm of soil in the CF mesocosm was much more highly reduced and anoxic than the PF soil. The plants in the CF mesocosm allocated a greater proportion of root production to finer roots in the shallower depths than the PF plants. This pattern could be explained by the production of surficial water roots by the flood stressed plants.

83

Megonigal, Patrick,[1] William Conner,[2] Steve Kroeger,[1] Rebecca Sharitz,[1] and John Day.[2] Savannah River Ecology Laboratory[1] and Louisiana State University[2]--*A regional comparison of primary production in forested wetlands across topographic and flooding gradients.* High net primary production (NPP) is an often cited functional attribute of forested wetlands. Swamp forests along topographic and flooding gradients in South Carolina and Louisiana are being studied simultaneously to determine: 1) the relationship between flooding frequency and NPP within a localized area and 2) regional variability in this relationship. The study includes nine sites on three transects in Louisiana and eight sites on three transects in South Carolina. Litterfall in Louisiana from March to October, 1987, ranged from 147 - 133 g m^{-2}; from April to October in South Carolina it ranged from 218 - 518 g m^{-2}. Higher totals in the latter region may be due to a more compressed fall season. The Louisiana sites with the lowest litterfall (147 - 203 g m^{-2}) were those which have been impounded, received artificial water table manipulation, or have rapid subsidence rates. Litterfall on the least disturbed sites ranged from 250 - 333 g m^{-2}. Sites in South Carolina are generally less disturbed, but show no clear relationship between flooding frequency and litterfall.

84

Kroeger, Steven[1], William Conner[2], Patrick Megonigal[1], Rebecca Sharitz[1], and John Day[2]. Savannah River Ecology Laboratory[1] and Louisiana State University[2] -- *A regional comparison of forest vegetation along topographic gradients.* In 1987 a joint study between Louisiana State University and the Savannah River Ecology Laboratory in South Carolina was initiated. The study focuses on regional variation in bottomland hardwood forest vegetation and net primary productivity. Three pairs of plots (0.05 ha) were established along a flooding gradient in three Louisiana and three South Carolina forests. Species composition, density, basal area and species importance values were determined in each plot. All flooded plots in both states are dominated by *Taxodium distichum* and *Nyssa aquatica*. No single species dominated all plots in the intermediately flooded and upland areas. The differences in vegetation along topographic gradients are greater in South Carolina than in Louisiana, perhaps because topographic relief is greater in South Carolina. Tree density and basal area are greatest in the flooded plots in both states.

85

CONNER, WILLIAM H.[1], MICHAEL BRODY[2] and JOHN W. DAY.[1]--Louisiana State University[1] and National Wetlands Research Center, USFWS[2]--The impact of rising water levels on productivity and succession in Louisiana's coastal wetland forests. The coastal area of Louisiana contains extensive areas of forested wetlands. Three basins, Barataria, Verret, and Pearl River, are presently being studied in a joint Louisiana-South Carolina project. Vegetation composition, flooding patterns, values for the various basins were used in the U.S. Fish and Wildlife Service's FORFLO bottomland hardwood model to predict habitat changes in the bottomland and swamp forests of the three basins. Analysis of water gauge data in each basin reveals that apparent water level rise (AWLR) is 8.5 mm/year and 13.7 mm/yr for the Barataria basin (BB) and Verret basin (VB), respectively. This high AWLR is due mainly to regional subsidence. In the Pearl River (PR) basin there appears to be no AWLR. Sedimentation in the cypress-tupelo forests of BB is 6 mm/year versus 8.8 mm/yr in the cypress-tupelo forests of VB. On the higher and drier bottomland ridge in the VB, sedimentation is only 2.7 mm/year. Sedimentation rates are still being determined for PR. AWLR is greater than sedimentation in BB and VB leading to vertical accretion deficits of 2.5 mm/yr and 4.9 mm/yr in the swamps of BB and VB, respectively, and 10.8 mm/yr on the bottomland ridge in VB. This deficit is cumulative and is leading to a significant increase in the number of days flooded per year in each basin. If present trends continue, the forested wetlands in BB and VB will eventually be continually flooded and unable to reproduce themselves.

86

MADER, STEPHEN F. North Carolina State University--*Alteration of soil and hydrology influences growth of purple nut sedge.* Microsite changes created by soil compaction and displacement during forestry activities have been observed to affect revegetation of clearcuts. The response of herbaceous plants, particularly purple nut sedge (*Cyperus erythrorhizos*), indicates early recovery of net primary productivity following timber harvesting in river delta swamps. A greenhouse experiment was designed to examine the influence of soil compaction and moisture stress on purple nut sedge growth. Four bulk density treatments (0.6, 1.0, 1.4, and 1.8 g/cc) and three depth to water table treatments (inundated, 5.5 cm, and 10.0 cm) were imposed. Growth response was measured as component dry weight increment. Root weight, shoot weight, shoot length and tiller number responded parabolically to soil bulk density with predicted maximum at 1.0-1.1 g/cc and sharp decreases above 1.5 g/cc. Values for all response variables were greatest where pots were inundated, however, only root weight showed significant differences. High water table partially compensated for negative shoot length response at the highest soil bulk density level.

87

EVERS, D. ELAINE and CHARLES E. SASSER, Louisiana State University Coastal Ecology Institute- *Effects of herbivory on vegetation on delta islands in Atchafalaya Bay, Louisiana*.

Delaic islands in Atchafalaya Bay, Louisiana support extensive marshes dominated by *Sagittaria latifolia* and *S. platyphylla*. Exclosures were erected on the islands in the bay in September, 1985. Treatments included unfenced control areas and areas excluding furbearers and waterfowl, furbearers only, and waterfowl only in each site. Compared with unfenced control areas, vegetation in the exclosures had greater biomass, both above and below ground, and was more diverse. Species such as *Acnida tamariscina* were found only in the exclosures. In contrast *Justicia ovata* was far more abundant in unfenced areas.

88

ROBERTSON, DAVID J., ROSEMARIE GARCIA, and KATHYRN PIWOWAR. Florida Institute of Phosphate Research--*Viability of stockpiled peat for wetland reclamation*.

The value of salvaging peat from marshes, swamps and bayheads prior to mining and redistributing it onto wetland reclamation sites has been verified repeatedly by the Florida phosphate mining industry. The technique is applied routinely whenever peat is available. The value of the peat once it has been stockpiled has never been determined, even though reclamation planners often store the soil. Four characteristics of the peat that dictate its value are being evaluated over time at three storage depths. (1) The potential for introducing wetland vegetation via dormant seeds and pieces of vegetative material is being compared using peat samples collected bimonthly. Peat cultured under controlled conditions contains approximately the same number and types of propagules, regardless of the season it is collected. Predictably, hardwood swamp peat contains numerous tree seeds, and marsh peat contains exclusively herbaceous species. (2) When experimental plants are grown in stockpiled peat of increasing age, there appears to be little change in biomass over time, although there is significant variability among plantings that may mask subtle trends.
(3) Chemically, the peat stockpiles do not change significantly over time, although there is a trend toward decreasing iron and sodium with increasing depth.
(4) Physically, the piles become denser, less moist, and are comprised of increasingly larger particle sizes as they age.

89

CAPPELLATO, R. and M. ELOISE BROWN CARTER. Emory University, Atlanta--*Successional changes in a Piedmont deciduous forest at Panola Mountain State Conservation Park (1977-1986)*.

Sixteen plots (0.04 ha) in a relatively undisturbed deciduous forest were surveyed after a nine year interval. A plot to plot comparison showed an increase in biomass (21.85%) and basal area (18.43%) and a decrease in density in more than half of the plots. Changes in importance values of species in the canopy strata (DBH>10cm) confirmed the successional trend. *Quercus* species increased their percent importance values in the canopy strata from 30 in 1977 to 36 in 1986. *Carya* species showed no changes, retaining 36% of the total importance values, which is accounted for primarily by Mockernut hickory, still the leading canopy species. The continuing presence and importance of *Liriodendron tulipifera* (7.86%) supports the conclusions of Carter (1978) that oak-hickory-tulip poplar is the stable, permanent community for the deciduous forest at Panola and a community type for the Piedmont.

90 Wetlands-SWS

DELAUNE, R. D., J. WHITCOMB, and W. H. PATRICK, JR. Louisiana State University--*Marsh aggradation along the rapidly submerging Louisiana Gulf Coast*.

Comparing vertical marsh accretion to changes in water level along the Louisiana Gulf Coast has identified locations which are not keeping pace with submergence. Vertical marsh accretion determined by ^{137}Cs dating was measured at over 30 locations. From a coast wide view vertical accretion rates on the order of 0.7 - 0.8 cm yr^{-1} are not keeping pace with water level increases occurring at rates in many instances of over 1.0 cm yr^{-1}. Submergence rates were 4-5 times faster than reported eustatic sea level changes for the Gulf of Mexico.

91 Wetlands-SWS

PEZESHKI, S. R. and R. D. DELAUNE. Louisiana State University--*A comparative study of carbon assimilation and productivity of streamside and inland Spartina alterniflora*.

Carbon assimilation rates and above-ground biomass of *Spartina alterniflora* were studied in a streamside and inland salt marsh in Louisiana. Net photosynthetic rates ranged between 8 to 25 umol m^{-2}s^{-1} for streamside and between 4 to 19 umol m^{-2}s^{-1} for inland plants. The seasonal photosynthetic data indicated similar patterns for plants from the streamside and inland marshes. However, the average stomatal conductance and net photosynthetic rates were significantly lower for inland plants compared to streamside plants. A substantially higher leaf dry weight, leaf area index and above-ground biomass were recorded at the streamside as compared to inland site. The reduced photosynthetic activity in the inland marsh parallel the previously reported increases in anaerobic root respiration and elevated sulfide level of the inland marsh are major factors contributing to the lower productivity of this species on inland sites.

92

WEBB, DOSHIA and THOMAS E. WEAKS. Marshall University--*Periphyton community structure of an artificially destratified lake*.
The effects of artificial destratification on periphyton community structure were evaluated for Beech Fork Lake, a shallow monomictic reservoir in southern West Virginia. Thermal stratification of this lake results in formation of a well defined hypolimnion which is characterized, in part, by an almost complete absence of periphyton. Following artificial destratification, species diversity decreased in the epilimnion and increased in the metalimnion. While similar results were noted for most diatoms, *Navicula* spp. were reduced by 85 percent in the water column following destratification. During the 1985 and 1986 summer seasons, prior to artificial destratification, dominant species were of the genera *Lyngbya* and *Schizothrix*. However, for the same period in 1987, after the onset of destratification, *Lyngbya* spp. were replaced by *Oscillatoria* spp. as dominant periphyton.

93

ROGERS, DAVID S. and THOMAS E. WEAKS. Marshall University--*An analysis of plankton of an artificially destratified lake*.
The effects of artificial destratification on phytoplankton and zooplankton community structure were evaluated for Beech Fork Lake, a shallow monomictic reservoir in southern West Virginia. Species of phytoplankton and zooplankton were identified and counted for the corresponding epilimnion, metalimnion, and hypolimnion layers. Dominant species of phytoplankton and zooplankton respectively for each layer; epilimnion- *Schizothrix* and *Daphnia*, metalimnion- *Schizothrix* and *Anarma*, and hypolimnion- *Schizothrix* and *Keratella*.Densities were also established for the five dominant phytoplankton and zooplankton species, as well as the total phytoplankton and zooplankton present.

94

NORMAN, ROBERT and DONALD TARTER. Marshall University--*Effects of artificial destratification on the benthic populations in Beech Fork Lake, West Virginia*.
In May 1987, personnel at the U. S. Army Corps of Engineers, Huntington District, began operating four artificial destratification fans in Beech Fork Lake, Wayne County, West Virginia. Artificial destratification is a major technique used as an in-lake method for improving water quality. In order to collect base-line data, pre-destratification benthic collections were made in summer and fall of 1986 using Hester Dendy multiplate samplers. Four stations were selected for the benthic sampling. At two stations, divers with scuba gear installed multiplate samplers (triplicate) at depths of 5 and 15 feet for six weeks. At two additional stations, multiplate samplers were installed at 15 feet for six weeks. The same stations and procedures were followed in summer and fall of 1987. The following comparisons of benthic populations will be discussed in relation to changes in water quality: species diversity, equitability, number of taxa, number of specimens per square foot, and functional feeding groups (predators, shredders, collectors, grazers).

95

CULP, CAROLYN and THOMAS E. WEAKS. Marshall University--Periphyton community structure along thermal gradients in Beech Fork Lake, West Virginia, utilizing artificial substrates.
Artificial substrates were used to determine the influence of thermal stratification on the algal periphyton community structure of Beech Fork Lake, a flood control water impoundment in West Virginia with warm monomictic characteristics. Even though the lake has a poorly defined thermocline, density gradients in the water are distinct enough to produce a stable thermocline effect. In March, 1986, when stratification was just beginning, diatoms were more common with *Synedra* and *Fragelaria* the most abundant genera. Density in the hypolimnion was 52% of the density found in the epilimnion and all algal types were found. In August of 1985 and 1986 when stratification was well established, blue green algae became more common with *Schizothrix* and *Lyngbya* the most abundant genera. Density in the hypolimnion was 0.2% that found in the epilimnion with diatoms and blue green algae the only types found.

96

QUINN, P. MICHAEL, JR. and CLAY M. CHANDLER. Middle Tennessee State University--*Seasonal variations in popula-*

tions of crustaceans of a temporary pond in Murfreesboro, Tennessee.
Crustaceans were collected from a temporary pond in Murfreesboro, Tennessee, from 7 November 1982 through 1 December 1983. Three quantitative samples were taken weekly with a 3-l Van Dorn sampler from each of four sites, which represented the variety of habitats within the pond. Dissolved oxygen, pH, temperature, water level, specific conductance, and turbidity were also investigated. Twenty-seven crustacean species representing Anostraca, Cladocera, Ostracoda, and Copepoda were collected: however, Isopoda, Amphipoda, and Decapoda were present, but were not assessed quantitatively. Eubranchipus serratus, Ceriodaphnia megalops, Candona decora, C. scopulosa, Diaptomus stagnalis, D. sanguineus, Cyclops haueri, and C. bicuspidatus thomasi were most abundant during cooler months. Streptocephalus seali, Scapholeberis kingi, Ceriodaphnia quadrangula, Candona simpsoni, and Cypridopsis vidua had greater numbers during warmer months. Chydorus sphaericus, Simocephalus expinosus, Eucypris reticulata, Potamocypris elegantula, Physocypria globula, P. gibbera, Cyclocypria kinkaidia, Paracyclops fimbriatus poppei, Cyclops vernalis, and C. varicans rubellus exhibited no seasonal distribution pattern. Cypria ophthalmica and Attheyella americana were rare. Some species aggregated at particular locations within the pond. Temperature and water level appeared to be the major abiotic factors influencing crustacean populations. The anostracan species Streptocephalus seali and Eubranchipus serratus may be new records for Tennessee.

97

CONGDON, JUSTIN D. AND HAROLD AVERY. SAVANNAH RIVER ECOLOGY LABORATORY AND THE UNIVERSITY OF CALIFORNIA AT LOS ANGELES--Frequency of macho female snapping turtles.
Sexual dimorphism in the common snapping turtle (Chelydra serpentina) provides an opportunity to ask questions related to ecological and life history consequences of environmental sex determination. Adult male snapping turtles have longer tails in proportion to their body size than do females. Question 1. Do adult female snapping turtles exhibit substantial variation in the tail/plastron length ratio such that each adult female exhibits relative maleness and femaleness? The answer to this question is yes so the following question was asked. Is there a difference in clutch size, egg size or nesting frequency that can be associated with the relative maleness or femaleness of adult snapping turtle females? Data on reproductive females was collected on the University of Michigan's E. S. George Reserve from 1977 through 1987. The answer to the second question is a qualified yes. Reproductive characteristics of macho females was different from those of the most female females.

98

SMOCK, LEONARD A. Virginia Commonwealth University--Ecological characteristics of southeastern U.S.A. blackwater streams.
Blackwater streams and rivers are an important and diverse aquatic habitat of the southeastern U.S.A., occurring throughout the Coastal Plain. Their ecological characteristics are determined predominately by the physiography of the area, including in particular the flat topography, mostly sandy soils and close coupling with the often extensive floodplains. The relatively low slope of the streams affects sediment composition, water velocity and chemistry, and ultimately the biological characteristics of the streams. Streams typically have a high dissolved organic carbon concentration (imparting the dark color) and high acidity. Buffering capacity and nutrient concentrations usually are low. Rates of primary production normally are low, with the systems being highly heterotrophic. Inputs of detritus from the floodplains are a particularly important aspect of energy flow in these streams, controlling bacterial growth and ultimately having a major influence on secondary production. Species richness of macroinvertebrates is similar to, and fish diversity is considerably greater than, that in higher-gradient streams. Macroinvertebrate community composition does not strictly follow the River Continuum Concept, with a paucity of shredders and scrapers in the headwaters and middle-order streams, respectively. Collector-gatherers and filterers predominate throughout the river system continuum. Particularly significant environmental perturbations of these streams usually are associated with agricultural practices, including especially channelization and non-point nutrient and sediment inputs.

100

PEARSON, WILLIAM D. and B. JUANELLE PEARSON. University of Louisville and Spalding University--Streams and medium-sized rivers in the Mississippi River Drainage of the southeastern United States.
The primary medium-sized rivers of the Mississippi Drainage within the southeastern U. S. include 42 major drainage basins. The physical and chemical characteristics of the streams and rivers in these basins are described in relation to edaphic features and land-use practices. The plant and animal communities of the systems are characterized, with emphasis on the many wild and scenic rivers, the unique mussel fauna of the Cumberland system, the percid fish faunas of the systems, the effects of reservoir construction on habitat and biota, and management concerns for the future.

101

MILLER, ANDREW C., and C. H. PENNINGTON. US Army Engineer Waterways Experiment Station--Physical and Biological Characteristics of The Tombigbee River.

The Tombigbee River, which is 618 km long and drains 50,500 sq km, originates in northeast Mississippi, flows southeast into Alabama, then joins the Alabama River to form the Mobile River near Mobile, Alabama. Prior to construction of the Tennessee-Tombigbee Waterway, the upper section of the river (from Amory to Aberdeen) consisted of sand and mud substrate and the macroinvertebrate fauna was dominated by *Hexagenia bilineata* and annelid worms. In the midsection (Aberdeen to Pickensville), which consisted mainly of sand and gravel, net spinning caddisflies and freshwater mussels (including commercially valuable species (*Megalonaias gigantea* and *Amblema plicata*) were abundant. A total of 116 species of fishes have been identified in the Upper Tombigbee Watershed; 97 from the Tombigbee River. Common sport fishes now include *Micropterus salmoides*, *Pomoxis* spp., and *Stizostedion vitreum*, and commercially valuable species such as *Ictalurus* spp., *Aplodinotus grunniens*, *Ictiobus* spp., and *Cyprinus carpio*. Waterway construction benefited lentic organisms at the expense of lotic species. However, habitat development projects, which include gravel bars near Columbus, Mississippi, fish attractors in the reservoirs, and improvements of selected bendways, will preserve some of the original conditions of the Tombigbee River. This research was supported by the Environmental Impact Research Program of the US Army Corps of Engineers.

102

Crisman, Thomas L. University of Florida--*The structure and function of natural lakes of the warm temperate-subtropical transition in the southeastern United States.*
Natural lakes of the southeastern US fall into five categories: Carolina Bays, oxbows, mountain ponds, earthquake (Reelfoot), and solution basins in Florida. Of these, a majority (7,700) are represented by the final category. Lakes of the region represent a climate gradient from warm temperate to the subtropical conditions of peninsular Florida. Subtropical Florida lakes are characterized by less pronounced seasonality in both temperature and primary production as well as altered seasonal cycles of zooplankton compared to lakes farther north. Major faunal and floral differences are noted among Florida lakes dictated largely by local geology (carbonates, leached sands, phosphates) and degree of humic color. Because of the subtropical climate, Florida lakes have been plagued by management problems resulting from the introduction of exotic plants and animals from the tropics. Additional development related lake management problems for Florida and the other lake categories of the Southeast will also be discussed.

103

SCHROEDER, W. W., M. R. DARDEAU J. P. STOUT AND R. F. MODLIN. University of Alabama, Dauphin Island Sea Lab, University of South Alabama, and University of Alabama in Huntsville--*Southeastern Estuaries.*
Southeastern estuaries are located along a latitudinal gradient from temperate to tropical waters. The estuarine biota of the upper Gulf coast and lower east coast are similar and best characterized as warm temperate. On the other hand, estuaries of the Florida peninsula south of Cape Canaveral on the east, and Cape Romano on the west support some tropical species, including coral and mangrove associates. The majority of estuarine fauna, however, are broadly ranging, eurythermic species which can be found from North Carolina to the southern Caribbean. Highly variable abiotic factors such as salinity, tidal amplitude, dissolved oxygen, turbidity, depth, wave action, and pollutants as well as biotic interactions like competition, predation and parasitism affect the distribution and abundance of organisms in the estuary. Substrate and vegetation, however, structure animal communities into recognizable assemblages. Accordingly, the estuarine biotope can be subdivided into six habitats: (1) intertidal emergent wetlands, (2) seagrass meadows, (3) unvegetated soft bottom, (4) hard bottom, (5) water column and (6) aerial habitat. Determining the structure and function of biotic communities within these habitats is a topic of ongoing research in estuarine communities.

104

COLLINS, BEVERLY S. Savannah River Ecology Lab--*Organization of forest herb communities.*

Forest herbs are often nonrandomly distributed over space and time. The objectives of this paper are to 1) present the patterns of herb distributions within mesic deciduous forest communities, 2) examine the potential causes of these distributions, and 3) discuss the consequences of distribution patterns for ecological studies. Spatially patchy herb distributions have been attributed both to positive or negative interspecific associations, and to herb response to the microenvironment. Temporally patchy distribution of herbs as phenological guilds, or groups of species with overlap of the photosynthetic phase of seasonal growth, coincides with phases of tree canopy development and the accompanying environmental changes. Within a guild, herbs often share a common ecophysiology, including photosynthetic capability, water relations, and nutrient use. In general, herb distributions reflect plant response to neighbor plants and to the physical environment. Knowledge of distribution patterns can provide a base for further studies of forest herb ecology.

105

BASKIN, CAROL C. and JERRY M. BASKIN. University of Kentucky--Ecology of mesic forest herbs: Germination ecophysiology and evolutionary aspects. Seeds of mesic herbs of the eastern deciduous forests of North America exhibit physical, physiological, morphological and morphophysiological dormancy, with morphophysiological dormancy (MPD) being the most prevalent type. Seeds with physical and physiological dormancy have fully developed embryos, while those with morphological and morphophysiological dormancy have underdeveloped (small) embryos. Six types of MPD have been found in mesic herbs, and in all types the seeds require warm, cold or warm plus cold stratification for germination. Seeds that require only cold stratification are considered to be more advanced than those that require warm or warm plus cold stratification. Since many species with an Arcto-Tertiary pattern of distribution have MPD and since some species in the same genera that now live on separate continents have the same type of MPD, it is assumed that MPD was present in the Tertiary. Other evidence that MPD has been present for millions of years is its occurrence in living representatives of genera of gymnosperms and angiosperms that have a fossil record extending back to the Tertiary or before.

106

BASKIN, JERRY M. University of Kentucky--Ecology of mesic forest herbs: Ecophysiology of photosynthesis. This talk is based on a literature review of the ecophysiology of photosynthesis of mesic woodland herbs of deciduous forests of North America, Europe and Japan. Apparently, all of them fix carbon via the C_3 pathway; none has been reported to be a C_4 of CAM species. Photosynthetic characteristics of mesic woodland herbs differ among species with regard to phenology in relation to tree canopy development. Species such as *Erythronium americanum*, in which the leaves develope before canopy expansion, have higher light compensation points, light saturation points and maximum photosynthetic rates than species in which the leaves develope during (e.g., *Podophyllum peltatum*) or during and after (e.g., *Trillium grandiflorum*) canopy closure. However, within species photosynthetic characteristics change with progression of season and with leaf development and age. For species that are photosynthetically active after canopy closure, changes such as lowering the light compensation point and increasing photosynthetic unit size are mechanisms whereby mesic deciduous forest herbs acclimate to the reduced light level at the forest floor.

107

MULLER, ROBERT N. University of Kentucky --Patterns of influence of the herbaceous layer on nutrient cycling in mesic forests. The influence of the herbaceous layer on forest ecosystem dynamics is frequently ignored due to its low overall biomass. Mesic forest herbs usually account for <3% of above-ground net primary productivity. As a component of NPP in ephemeral parts (lifespan <1yr) they contribute up to 10%. Since ephemeral parts turnover most rapidly and contribute the largest amount of nutrients to the soil it is perhaps more appropriate to consider mesic forest herbs in this context. Nutrient contents of herbaceous foliage are generally higher than in foliage of trees. As a result, the herbaceous layer may contribute a significant amount of the total nutrient return in leaf fall. This nutrient-rich litter decomposes rapidly in contrast to more lignified canopy litter and represents a pool of least recalcitrant material. Adaptations of herbaceous species to the seasonal environments of deciduous forests have resulted in a variety of temporal niche separations. Spring herbs which are restricted to aboveground growth during the short season between rising spring temperatures and canopy development represent an important biological sink for available nutrients. Uptake and fixation of nutrients at this time provides a mechanism of nutrient retention and extends the seasonal biotic influences on nutrient cycles.

108

MOTTEN, ALEXANDER F. Duke University. Pollination, resource availability, and seed-set in two North Carolina populations of *Erythronium umbilicatum*.

Erythronium umbilicatum, a single-flowered forest spring ephemeral, typically exhibits 45% seed-set. The causes of this naturally depressed seed-set were examined with a combination of fertilizer, shading, and hand cross-pollination treatments. There were no significant differences among treatments or controls in a randomized block design, even when plant size (leaf area) was used as a covariate. Seed-set was not limited by current year's supply of N, P, or K, and was unaffected by artificial reductions in photosynthate supply by whole plant and single-leaf shading. Seed-set was also not significantly enhanced by extensive hand-cross pollination or by a combination of cross-pollination and nutrient addition. However, plant and flower size the following year increased for plants that received nutrient addition and decreased for plants in the shading treatments. The probability of flowering and flower size (and hence ovule number and anther size) were also inversely correlated with seed-set the preceding year. Individuals can thus compensate for reduced female reproductive success one year with the potential for increased female fitness (via higher ovule number) and possibly increased male fitness (via larger anthers) the next year. The phenology of resource use and supply and the history of reproductive effort are essential yet often neglected components of reproductive effort in long-lived perennial herbs.

109

WEIN, GARY R. Savannah River Ecology Laboratory, University of Georgia--*Demography of clonal forest herbs*.

Many forest herbs are clonal. The extent of clonal production influences both the spatial and temporal structure of herb populations. In this talk, I present the life history of several mesic forest herbs, contrast methods for assessing herb population dynamics, and examine the consequences of clonal growth for resource partitioning. *Erythronium americanum*, a common clonal herb of mesic deciduous forests, will be used as an example for this discussion. Typically, forest herb populations have many nonreproductive ramets, and few flowering individuals or seedlings. Few species maintain permanent structures or connections among ramets; thus, determining the age of individuals is difficult, and resources cannot be shared among ramets. These herbs are dependent upon stored reserves to survive dormant periods, and dormancy may be the time of greatest mortality for individuals that fail to store adequate carbohydrate reserves. For herbs that maintain ramet connections, resource sharing may buffer times of stress. The influence of clonal growth on population structure is a primary determinant of mesic forest herb demography.

111

FOLKERTS, GEORGE W. and RONALD D. CAVE. Auburn University, and Escuela Agricola Panamericana--*Avoidance of ant attack by the larvae of the myrmecophilous syrphid fly, Microdon sp.: microstructure and behavior*.

The molluscIform larvae of an undescribed species of *Microdon* inhabit the nests of carpenter ants (*Camponotus* sp.). Although they feed on the ant larvae they are not attacked by the ants. The *Microdon* larvae do not produce a repellant, nor do they produce any substance to which the ants are attracted or on which the ants feed. Larvae taken from ant nests are covered with an adhering layer of detritus which consists mainly of wood particles and ant feces. This material is glued to the dorsum of the larva by a fluid extruded from the mouth. When produced, the fluid rapidly flows upward and coats the dorsum of the larva. The rapid transport of the material results from the micropapillate structure of the dorsal cuticle which functions to make the dorsum hyper-wettable. Hook-bearing setae on the dorsum also function in retention of detritus particles and may scrape material from the walls of the ant nest. It is proposed that the larvae avoid attack because the ants interpret them as components of the substrate.

112

HOPKINS, T. S. AND B. R. HUGHES. University of Alabama (Marine Science Program), Dauphin Island Sea Lab--*Experimental studies of salinity tolerance in Branchiostoma florida Hubbs*.

The estuarine passes of coastal Alabama are inhabited by dense populations (ca. 100/0.01m^2) of *Branchiostoma floridae*, Hubbs, and exposed to wide ranging benthic salinity fields (0-36 o/oo) during episodic events. In 96 hr controlled temperature (15 and 20^{o}C) exposure to varying salinity treatments, *B. floridae* survived at 35 and 40 o/oo respectively but suffered > 50% mortality at salinities < 20 o/oo. We speculate that either mass mortalities occur, or burrowing behavior and pore water solutes maintain the animals osmotic integrity during low salinity episodes.

113

SMITH, ALBERT K., CLETUS M. SELLERS, JR., and NORMAN E. GARRISON. James Madison University--*The effects of acidification on plasma protein concentrations of rainbow trout (Salmo gairdneri)*.

Rainbow trout (*Salmo gairdneri*) were subjected to pH 4, while blood samples were obtained via dorsal aortic cannulation. Relative plasma protein concentrations of 13 different proteins were statistically analyzed to ascertain whether 1) the relative protein concentration changed and 2) the changes in the concentration could be correlated with time. Five proteins increased significantly in relative concentration in plasma samples taken from trout exposed to pH 4 ($p < 0.05$). Two other proteins also tended to increase in relative concentration, but at a less significant level of probability ($p < 0.10$). Increases in relative concentrations were not significantly correlated with time.

115

JONES, LEE R. Emory University--*High and low temperature tolerances of black-billed magpie embryos and the thermal environment of roofed and roofless nests*.

Black-billed magpies lay and incubate eggs in the Great Basin desert of northern Utah between March and May when highly variable air temperatures, solar radiation intensities and wind speeds can cause egg temperatures (T_e) to rise or fall substantially above or below normal incubation temperatures if the parents are absent from the nest. The tolerance of magpie embryos to such changes in T_e was examined by heating or cooling eggs of known age in the field with a simple thermal chamber in which T_e could be carefully monitored and controlled. Embryos of all ages survived low T_es between 2°C and 5°C. All embryos also survived high T_es of 42°C and 43°C. Some embryos survived T_es of 44°C and 45°C, but no embryos survived T_es of 46°C. Magpie nests are large, bulky stick and mud structures which usually, but not always, have a domed roof that shelters the nest bowl. Field measurements and a predictive model of heat transfer by eggs in roofed and roofless nests confirm that fluctuations in T_e during parental absences are reduced in roofed nests, so that T_e is less likely to reach lethal temperatures than in roofless nests.

116

MILLS, EDWARD D. and DAVID T. ROGERS JR. University of Alabama--Wintering migrant-resident bird ratios in Belize, Central America.
During 26 November 1986 - 11 March 1987 we sampled wintering migrant and resident birds with mist nets in a 1400 ha citrus plantation in central Belize. We netted in grapefruit and orange orchards of various ages (6 - 20 yrs), with block sizes ranging in area from 1.5-10 ha. We captured a total of 23 migrant and 35 resident species during the 3650 net hours. Percentage migrants ranged from 44% to 69%, with Black & White (Mniotilta varia) and Magnolia (Dendroica magnolia) Warblers being the most abundant. The Rufous-tailed Hummingbird (Amazilia tzacatl) was the most abundant resident. The number of migrant species is higher here than reported elsewhere in the Yucatan Peninsula and Guatemala, and falls in line with other studies showing a southeastly trend of increasing migrant proportions in the Yucatan Peninsula.

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RANGLACK, GEORGANNA S. AND KEN R. MARION. UNIVERSITY OF ALABAMA AT BIRMINGHAM--Demographics of a heron rookery: Observations on controlling factors.
Factors controlling hatching success and nestling survivorship in a large mixed-species heron rookery in Alabama were studied for four seasons. Cattle egrets (Bubulcus ibis) comprised more than 90% of the nesting population. Hatching success and nestling survivorship of cattle egrets were variable between years, but not dramatically so. Annual hatchling success varied from 60% to 75%. Nestling survivorship to approximately two weeks of age averaged 65%. Preliminary analyses indicate that nests established on the peripheral areas of the colony had similar success rates as those established in central areas. Eggs laid in nests established late in the season had a lower hatching success rate when compared to those laid during the major nesting period. Tree diameter and height were factors affecting nesting success. Nestling mortality increased during extended wet periods.

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LAMBERT, EDWARD P. and WINSTON PAUL SMITH. Southeastern Louisiana University, and Tennessee Technological University--Age and sex differences in seasonal movements and habitat use by Eastern Wild Turkey in a farmland - timberland interspersion.
During March 1983, 1 adult and 4 subadult male turkeys were captured with a cannon net; in October 1983, 5 additional subadult males and 5 subadult females were captured. Birds were fitted with radio-transmitters and monitored continuously through May 1984. Two adult males that survived 14 months ranged an average of 1,635 ha. Seasonal home ranges were similar among sex and age classes. Overall home ranges of males were larger than those determined for hens within the present study area. An adult male exhibited the largest daily movement (7.6 km); otherwise males had similar movement patterns with the largest and smallest movements occurring during spring and summer, respectively. Females and males had similar daily movements but males appeared to take more frequent forays into different portions of their range. A total of 2,525 locations were recorded in 6 of 13 habitats; birds concentrated their activity in habitats surrounding dairy farms. Overall, turkeys preferred old pine plantation (76.5% of total locations) and mixed pine-hardwood (5.8%). Birds avoided young pine plantation (0.6%), deciduous thicket (0.1%) and improved pasture (8.7%); hardwood forest was used proportionally. Males had centers of activity (50% home range) that were about twice those of hens, but core habitats (within center of activity) were similar: old pine, mixed pine hardwood, hardwood forest and improved pasture. Conclusions related to use of improved pasture were probably a result of overestimating availability (using abundance). Spatial configurations of preferred habitats and high frequency of use suggest that dairy farms are a crucial component of habitat in southeastern Louisiana timberlands.

119

BARRY, RONALD E., JR. Frostburg State University--Microhabitat selection and dispersion by three syntopic rodents in Maryland.
Peromyscus leucopus (the white-footed mouse), P. maniculatus (the deer mouse), and Clethrionomys gapperi (the red-backed vole) were syntopic in an Appalachian forest in western Maryland at an elevation of 600 m. Dispersion and spatial relationships of these three species were examined on a study site with 76% rock cover. A live-capture study on a one-hectare grid in the summers of 1985 and 1986 revealed consistent negative spatial relationship between the Peromyscus species and periods of positive spatial association between the deer mouse and red-backed vole. Analysis of microhabitat associations of the three species suggested ecological isolation between the two Peromyscus and similar microhabitat affinities for the deer mouse and vole. The white-footed mouse avoided sites with the most abundant rock cover, but the deer mouse and vole were positively associated with such sites. Conversely, the white-footed mouse was positively associated with sites characterized by high densities of stems, while deer mice and voles appeared to prefer moreopen sites. Features of the microhabitat (especially rocks) and the presence of conspecifics were both important in accounting for the distributions of captures of the three species in regression analysis. Reasonably consistent occupancy patterns and readily identifiable microhabitat associations exhibited over the two summers are evidence that microhabitat preferences

contributed significantly to the dispersion of the locally sympatric rodents.

120

GREENBERG, C. H. and P. D. PARR. University of Tennessee, and Oak Ridge National Laboratory--Gray fox ecology: food habits, habit use, and home range on the Oak Ridge National Environmental Research Park.

The food habits of gray foxes (*Urocyon cinereoargenteus*) on the Oak Ridge National Environmental Research Park in east Tennessee were investigated for seasonal trends in 1986-87. Scat analyses (n=170) revealed fruit to be the most important food group, followed by insect and vertebrate material (determined as percent of scat by dry weight of undigested remaining food material). Seasonal shifts between the three food categories were statistically significant and reflected food availability: fruit in summer/fall; insects in spring; and, vertebrates in winter. Gray foxes (n=12) were collared with radio transmitters and located every 2 hours one day a week between 1600 and 0800 hours. Home range calculations and habitat use analyses were assessed with these data. Small mammals were trapped in four habitat types within the study area to provide a prey population index. Seasonal variation in home range size and habitat use are examined in relation to seasonal dietary shifts, prey availability, and the breeding cycle.

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121

BAILEY, MARK A. and ROBERT H. MOUNT. Auburn University--Movement of the dusky gopher frog, *Rana areolata sevosa*, at a breeding pond in the Lower Coastal Plain of Alabama.

The natural history and population ecology of the gopher frog/crawfish frog complex of *Rana areolata* are not well known, particularly in the Southeast. Adult *Rana areolata sevosa* were monitored as they immigrated to and emigrated from a breeding pond in southern Alabama during the winter of 1985-86. A total of 269 individuals were marked and released after capture in pitfall traps along a drift fence that encircled the pond. Movement to and from the pond was positively correlated with rainfall and warming air temperatures. Males generally arrived at the pond earlier in the season and remained longer than females. Early-breeding individuals did not normally remain for the entire breeding period. Both sexes tended to emigrate from the same side of the pond at which they had originally immigrated. Daylight hours were spent in submerged vegetation on or near the pond bottom. Terrestrial movement, when it occurred, took place at dusk or after dark. The maximum number of males heard calling on a single night was seven, although at least thirty were known to be present at the time. Because the number of males heard calling at a given time is small, and because there is a significant turnover of individuals present through the season, any estimate of population size based on the number of males calling at a given time would likely be inaccurate.

122

HARKEY, GAIL A. and RAYMOND D. SEMLITSCH. Memphis State University --Effects of temperature on the growth, development, and color polymorphism in the ornate chorus frog *Pseudacris ornata*.

The effects of five temperature treatments (10 C, 15 C, 20 C, 25 C, 30 C) on larval development, growth, and color polymorphism of *P. ornata* were studied in the laboratory. Body mass and developmental stage on Day 32 increased with increasing temperature to 25 C, then decreased at 30 C. Mass at metamorphosis and time to metamorphosis decreased with increasing temperature treatments. Fewer deformities and greater average survival were found at intermediate temperature treatments of 20 C and 25 C than at the two extremes of 10 C and 30 C. No larvae metamorphosed from the 10 C treatment after 111 days and individuals only reached stage 30. Copper, brown, and gray metamorphs were produced from brown and gray parents; green morphs were not present. Proportion of the brown color morph increased with increasing temperatures, but proportion of the gray morphs remained relatively constant. The copper color morph was not observed at metamorphosis, but was distinctly apparent after several weeks post-metamorphosis. Alteration of temperature in the larval environment may explain some of the temporal and spatial variation in time to metamorphosis, size at metamorphosis, and relative frequency of color morphs in natural populations.

123

FORESTER, DON C. and DAVID V. LYKENS. Towson State University--The ability of wood frog eggs to withstand prolonged terrestrial stranding: an empirical study.

In Maryland, the wood frog, *Rana sylvatica*, oviposits in ephemeral ponds and pools during early spring. Seasonal precipitation is often unpredictable and egg masses may become exposed as pond levels recede. The ability of wood frog eggs to withstand prolonged terrestrial exposure was tested in the laboratory. Egg mortality rate was exponential. Compared to a control, 49% of the eggs died within two days, but 11% of the eggs were alive after 10 days and a few survived as long as 14 days. Wood frogs are thought to have evolved communal oviposition as a mechanism to minimize thermal stress during development. We suggest that this behavior preadapted egg masses to withstand terrestrial stranding. Today, advantages accrued through reduced thermal exposure and resistance to desiccation likely act in concert to stabilize communal egg laying behavior.

124

VOSS, S. R. Western Carolina University--Inter- and intra-populational variation in age-specific metamorphic frequency and larval growth in southern Appalachian populations of *Eurycea wilderae*.

The seasonal pattern of metamorphosis according to age and body size was elucidated for *Eurycea wilderae* larvae in four southern Appalachian drainages. At each drainage a small first order tributary was paired with an adjacent higher order section of the main stream. A bimonthly sampling program during the summer of 1987 showed that larvae metamorphosed after 1 year in all first order streams except one, while in larger streams larvae metamorphosed after 1 or 2 years. The length of the metamorphic season varied between and within drainages. Also inter- and intra-populational variation in the body size of metamorphosing larvae was observed, with smaller body sizes recorded for metamorphosing larvae in the first order streams. In all populations studied, there was a slight decrease in metamorphic size during the metamorphic season.

Although hatchling larvae appeared first in the first order streams, larvae in these tributaries appear to grow at a slightly slower rate than those in higher order streams. Embryonic development may be faster in the first order streams, or oviposition and nesting by mature females may began at an earlier time.

125

SCOTT, DAVID E. and J. W. GIBBONS. Savannah River Ecology Laboratory--The effect of metamorph body size on adult body size and survival in the marbled salamander, *Ambystoma opacum*.

In species with complex life cycles, little is known concerning the effect of larval and metamorph traits on postmetamorphic growth and survival. We examined the effect of larval performance on traits presumably related to adult fitness in the marbled salamander, *A. opacum*. Larvae were raised in large-scale (36 m^2) field enclosures at two density levels (7 individuals/m^2 and 35/m^2) in two years. Larvae from the low density treatment grew faster and attained a significantly larger body size at metamorphosis. Individuals from the 1986 cohort returned to their natal site to breed in 1987 at two years of age. Those from the low density larval environment returned as larger adults ($P<0.001$). Approximately 15% of those from the low density pens returned at age 2, compared to 6% of animals from the high density enclosures. Because reproductive success in salamanders is related to body size, these results indicate that the larval environment may affect adult body size, age at first reproduction, survival, and thus reproductive success.

126

ESTES, RUTH A. AND DAVID E. SCOTT. Savannah River Ecology Laboratory--Lipid utilization by adult marbled salamanders (*Ambystoma opacum*) during the breeding season.

Lipid utilization during the breeding season was studied in the marbled salamander, *Ambystoma opacum*. Adult *A. opacum* enter breeding sites in the fall, when the sites are dry. Males arrive a few weeks before females. After breeding, females constuct nests and brood the eggs until their nests are inundated by fall rains. Male and female *A. opacum* (N=80) were collected before and after breeding. SVL and wet mass measurements were taken for each animal. The body was then dissected into components for lipid analyses. The carcass, fat bodies, liver, reproductive organs, and eggs were removed and analyzed for lipid content. Both males and females exhibited reduced lipid levels after breeding ($P<0.01$). Prior to breeding, males and females showed no difference in total carcass lipid levels ($P>0.05$). Body size had a significant effect on lipid levels ($P<0.01$). After breeding, however, males left the pond site withsignificantly higher total carcass lipid levels ($P<0.01$). Fat body, testis, and ovary size are also much reduced after breeding. Females showed no evidence of feeding while brooding their nests. However, most exiting males had somestomach contents. These results may indicate that there is an energetic cost of brooding in *A. opacum*.

127

ANDERSON, ROGER. A. Savannah River Ecology Laboratory---Sexual dimorphism and sexual selection in the lizard *Cnemidophorus tigris*.

The presence of sexual dimorphism and its causal features were investigated in a field study of a population of *C. tigris* in the Sonoran Desert of California. Adult males (90.5 mm snout-vent length) were larger than adult females (86.5 mm snout-vent length). Capture-mark-recapture method revealed young adult males to grow faster than young adult females during the reproductive season: males = 0.125 mm/d; females = 0.051 mm/d. Males also grew more than females between their first and second reproductive seasons (males = 8.2 mm; females = 5.0 mm). Adult males had larger heads and heavier bodies than females of equal snout-vent length ($p < 0.05$, ANCOVA). Behavioral evidence via field observations is consistent only with the hypothesis that large body size in males is caused by sexual selection. Larger males dominated in intrasexual aggressive encounters. The largest quarter among males were involved in over half the mating pairs. A low operational sex ratio of 0.16 and high encounter frequency (0.75 meetings per hour) among individuals caused intense competition among males, hence intense intrasexual selection in these non-territorial lizards.

128

FISCHER, ROBERT U., DAVID E. SCOTT, SCOTT A. BUSA, AND JUSTIN D. CONGDON. SAVANNAH RIVER ECOLOGY LABORATORY -- Reproductive and lipid cycles in the cottonmouth, Agkistrodon piscivorus. During each of seven one-week periods in 1985-1987 we systematically collected 30-40 individuals of the eastern cottonmouth, Agkistrodon piscivorus, from the Savannah River swamp system in Aiken County, South Carolina. The reproductive condition of each adult was determined, and lipids were extracted from the fat bodies, liver, gonads, and carcus using petroleum ether and a soxlet apparatus. Individual eggs and embryos from pregnant females were also extracted. Analysis of covarience indicated that both the sex and the size of the snake, as well as the month of capture, had significant effects on the total lipid concentrations ($P<0.05$). Sex and month also affected fat body lipid concentrations, but not liver or carcass lipids. Total lipids levels in females were two times greater than males immediately prior to breeding (April). Lipid levels also tended to differ between years, perhaps in response to altered habitat/resource availability.

129

DILLER, LOWELL V. and RICHARD L. WALLACE. Frostburg State University and University of Idaho - - Feeding ecology of the Northern Pacific rattlesnake (Crotalus viridis oreganus) in northern Idaho.

Over 100 prey remains from 100 Crotalus viridis oreganus were collected and analyzed from 1978 through 1987. Nine species of mammals, one bird and one lizard were identified as prey, but voles (Microtus sp.) were the most common prey utilized. Snakes fed from late April to late October. The rattlesnakes in this study showed ontogenetic shifts in food habits, but only among the species and size of mammalian prey taken. We found no evidence that neonates fed until spring following their first hibernation. Pregnant females fed as late as early August and postpartum females actively fed in late September and early October. We believe that feeding done by females when they are pregnant and following parturition allow many females in our study area to reproduce in successive years.

130

KEN BLAIR AND BEVERLY KNAUPER. Cumberland College--ELISA Immunoassay of Snake Venoms

This research detected various snake venom antigens by the enzyme linked immunoassay (ELISHA). A comparison of monovalent and polyvalent antivenoms was performed using venoms from various snake species. The effects of various venom storage conditions on immunological reactivity with antivenoms was also examined. The polyvalent antiserum displayed a higher titer against the Crotalid venoms than against the Agkistrodon venoms. Storage under various conditions had no effect on immunological reactivity.

131

JACKSON, JAMES F. University of Southwestern Louisiana--Predator avoidance and crevice occupation by musk turtles. Presented with a choice of moving into a flow of plain water or a flow of water with odorants from either Pseudemys or Macroclemys, Sternotherus minor peltifer and S. carinatus were significantly less likely to enter the Macroclemys-influenced flow than the flow influenced by Pseudemys. Activity in the Macroclemys-influenced flow was significantly less in both Sternotherus species, and speed in the Macroclemys-influenced flow was lower in S. carinatus. Buccal pumping of water through the external nares was significantly more frequent in both Sternotherus species when in the Macroclemys-influenced flow. In another set of experiments, musk turtles of eight geographic samples and five taxa preferentially used crevices as resting sites in laboratory pools. Crevice use was greater during the day. Larger, darker crevices that were low enough to touch the carapace were preferred. Positional preferences within crevices were for full coverage of the shell despite the head being exposed, for the low half of crevices, and for axial orientation that maximized contact between the carapace and crevice ceiling. Light but touchable portions of crevices were preferred over dark but untouchable portions, so the possibility of establishing carapacial contact with the ceiling is the definitive attribute of a satisfactory crevice. The pattern of transfer between crevices suggests that initial attraction to a crevice was influenced by light level but that continued occupation of the crevice was influenced by the capacity for touch. The behavioral tendency to use the lowest possible crevice may have an antipredator function, and it is one necessary condition for existence of a selective regime in favor of depressed shells.

132

DUNN, CHRISTOPHER P., REBECCA R. SHARITZ, and ROBERT C. KELLY. Savannah River Ecology Laboratory, University of Georgia--Phenotypic plasticity in Aneilema keisak: field and greenhouse experiments. Aneilema keisak (syn = Murdannia keisak: Commelinaceae) is a common wetland annual herb in the southeastern United States. The effect of thermal pollution on populations of this species was studied in a South Carolina bald cypress - water tupelo forested wetland. Four populations were studied: 2 receiving thermal pollution (with open canopy following death of trees) and 2 not receiving pollution (closed canopy). Plants from thermal sites were significantly shorter (40 vs 120 cm), more dense (10,000 vs 2,000 plants/m2), and produced fewer branches (1 vs 3 branches) than those from nonthermal sites. Thermal plants also produced more flowers per plant (15 vs 11), but lighter seeds (2.6 vs 3.9 mg). High density populations display features of r-strategists and tend to self-thin whereas low density nonthermal populations display features of K-strategists. Greenhouse experiments (shade, temperature, water depth) were conducted to ascertain whether these differences were genetically determined or environmentally cued. Data indicate that this species is plastic in its response to thermal pollution.

133

KING, BRUCE L. Randolph-Macon College--Germination Ecology of false foxglove, Aureolaria virginia.

Seeds of A. virginica were innately domant at dispersal in early fall. Dormancy was broken by cold stratification. Optimum stratification temperatures were near 5 C and the optimum germination themoperiod was approximately 20/10 C. Higher and lower stratification temperatures and summer-like thermoperiods inhibited germination. Greater germination frequencies were found for large seeds than small ones. There was a differential seed germination response among the three years of the study. The variable stratification and germination response may be regarded as adaptations for maximizing the likelihood of surviving in a patchy and unpredictable environment.

134

CARTER, M. ELOISE BROWN and ELIZABETH GUTHRIE. Emory University--Genetic variation in Trillium persistens, a federally endangered species.

Trillium persistens, a federally endangered species, is endemic to the Tallulah Gorge - Tugaloo River system of northeast Georgia and adjacent South Carolina. A survey of genetic variation in five of six known populations was initiated in 1986 as part of the Recovery Plan. Leaf tissue from 98 individuals was analyzed using gel electrophoresis for six enzyme systems. Five of the 14 gene loci detected were monomorphic. Heterozygosity was high, ranging from 0.06 to 0.12 (X = 0.09). Three populations exhibited population-specific alleles at low frequencies. Genetic identity values were high (0.947 to 0.996). Trillium persistens flowers early and is capable of self and cross-pollination. Most populations occur on separate tributaries, and gene flow might be expected to be low. However, preliminary results suggest that high levels of genetic variation are being maintained in persistent trillium.

135

PORCH, SUSAN S. and GEORGE W. FOLKERTS. Auburn University--Leaf lifespan and trapping area in three species of Gulf Coast Drosera.

Isolated boggy sites on the Coastal Plain of southern Alabama and northwestern Florida support a unique flora and fauna, including three species of carnivorous sundews (Droseraceae). These three species differ markedly in their growth habits. Leaf tagging studies conducted during the growing seasons of 1986 and 1987 indicated that the mean leaf lifespan was 52.0 days for Drosera tracyi, 40.8 days for D. intermedia, and 43.4 days for D. capillaris. Differences in leaf lifespan occurred between years and among the three sites, a Walton Co., FL site having the longest-lived leaves in 1986 and a Baldwin Co., AL site having the shortest-lived leaves in 1987. The mean number of leaves/plant/year was 33.0 for D. tracyi, 70.5 for D. intermedia, and 43.0 for D. capillaris. Estimates of leaf surface area showed that Drosera tracyi, with its long, filiform leaves, exposed significantly greater trapping area per year than did the other two species.

136

FOLKERTS, DEBBIE R. and D.A. CROSSLEY, JR. Auburn University and University of Georgia--Pitcher plant prey: a limited resource?

Pitcher plants of the genus Sarracenia (Sarraceniaceae) exhibit a diversity of leaf morphology which results in resource partitioning of insect prey. This resource partitioning may have been the result of interspecific competition during the evolutionary history of the genus. Competition for insect prey can only occur if the resource is limited. A study was conducted in a pitcher plant bog, with only one erect Sarracenia species, to determine if the prey resource was limited. Pitcher plant (S. alata) leaf contents were compared among 20 plots (1 m^2) of varying plant densities. Aerial insect traps were used to monitor prey availability during a 4 week period. Total mass of prey residues and prey diversity were greatest in plots of lowest plant density. Trap catches were greater at bog edges than at the bog center. The results indicate that the prey resource was limited at the time of the study.

137

FOLKERTS, GEORGE W. Auburn University--Dispersal types in the flora of pitcher plant habitats in the southeastern U. S.

Dispersal characteristics of the diaspores of 255 species of angiosperms characteristic of pitcher plant habitats in the southeastern Coastal Plain were determined by examination of diaspores, field and laboratory experimentation, and from information in the literature. Most of the species in these habitats are adapted to dispersal by rainwash hydrochory. Few anemochorous and almost no zoochorous species are present. The essential absence of zoochorous types is unusual for a wetland community. The dispersal spectrum of pitcher plant habitats differs markedly from those of adjacent plant communities such as shrub bogs and sandhill habitats where anemochory and/or zoochory tend to characterize many of the species. This conspicuous difference seems partially explainable by the fact that openness, low nutrient availability, and high humidity are characteristic of pitcher plant communities. Although flowering times among the species are distributed throughout the year, with few conspicuous peaks, a prominent peak in diaspore maturity and presentation occurs in the late summer and fall. Hurricane-generated rains may have been a selective factor in promoting this timing.

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WILCZYNSKI, C. J. and K. L. GROSS. University of North Carolina, and Kellogg Biological Station, Michigan State University--Small scale disturbance and seedling dynamics of two species of Hieracium in an old field.

Small scale disturbance is common in old fields and make them spatially heterogeneous. Disturbed patches may serve as foci for recruitment of seedlings thus allowing some species to persist within the community. However, the relative success of each species to persist may be affected by biomass allocation patterns, and by success of seedling recruitment. To assess these effects, biomass allocation patterns, and seedling emergence and survival of Hieracium aurantiacum and H. florentinum were monitored in undisturbed vegetation and experimentally disturbed patches in a 35 year old field in Michigan. There were differences in allocation patterns of these species. Overall, the emergence of H. aurantiacum was was higher than that of H. florentinum. Seedling emergence of both species was highest in bare soil, lowest in litter, and most variable in the undisturbed vegetation. There were no effects of patch size on seedling emergence. Seedling survival through the winter was low in both species. However, survival of H. aurantiacum seedlings was greatest in patches of bare soil and increased with patch size. There were no effects of patch size or type on survival of H. florentinum seedlings. Small scale disturbances and seedling recruitment can be considered of limited importance to the persistence of Hieracium species within this successional community.

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WILSON, ALLAN D. and DONALD J. SHURE. Emory University--Effects of the herb-shrub layer on black-locust (Robinia pseudo-acacia) growth.

An experimental approach was utilized to elucidate the potential importance of nutrient limitation versus competition during first and second year vegetative development in a clearcut in the southern Appalachian Mountains. Treatments included woody vegetation removal, herb-shrub removal and NPK fertilization on twelve 12x12 m plots established within the clearcut. Black-locust, an important early successional woody species, responded best to fertilization/herb-shrub removal. In contrast, black-locust growth following fertilizaton without herb-shrub removal was comparable to controls (no fertilization/no removal). Blackbery (Rubus spp.) growth appears to be the major cause for this reduction in black-locust growth. Thus, competition from the herb-shrub layer can influence the growth of a dominant tree species during early succession on southeastern clearcuts.

140

MCLEOD, KENNETH W. and MICHAEL A. CASCARINA. Savannah River Ecology Laboratory, and Villanova University--Use of artificial shade environments to predict natural responses.

The concept of shade tolerance is instrumental in explaining traditional forest succession. Yet, relative shade tolerance is usually determined by field observations or experiments utilizing shade cloths to manipulate the shade intensity. Shade cloths may create an artificial environment by changing the spectral quality of sunlight and/or eliminating sunflecks. Whereas, plants on the forest floor may be exposed to light intensities from almost full sun to heavily shaded due to season or presence of sunflecks, plants in shade houses receive only a light intensity of minimum variability. In this study, photosynthetic light response curves were determined for seedlings of red maple (Acer rubrum) and sycamore (Platanus occidentalis) exposed to either different shade intensities created by shade cloths or natural forest floor light conditions. Spectral quality of light in these different environments was found not to vary greatly. Photosynthetic light response curves for the two species differed, according to their different shade tolerance, but did not significantly differ between seedlings grown on the forest floor versus seedlings grown in a shade house of similar light intensity. Although utilization of shade houses has been maligned as being an artificial environment, neither light quality nor seedling photosynthetic light response curves deviated from that observed under a natural forest canopy. Thus, shade cloths represent a convenient, manageable method of manipulating light intensity.

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BENNETT, B. D., and JAMES GRACE Louisiana State University--Shade tolerance and its effect on the segregation of two species of Louisiana iris and their hybrids.
Iris fulva Ker. Gawler (IF) and *Iris hexagona* Walter (IH) have overlapping geographic ranges in Louisiana and in areas of overlap hybrids are fairly common. IH occupies the borders of freshwater marshes of southern Louisiana while IF can be found further north along edges of natural levees, canals and swamps When the natural levee penetrates the marsh, natural hybridization can occur between IH and IF. It has been suggested that one principal explanation for the segregation of the two species is that IF grows best in semishade and IH grows best in full sun A greenhouse study was conducted using rhizomes collected from the field to test this hypothesis Two natural hybrid taxa were also examined to determine if they were intermediate in their responses to shade IF, IH and the two hybrid taxa were grown under 0% (control), 50% (medium shade), and 79 % (high shade) reduction of sunlight for 6 months and then harvested IF was found to be more tolerant of shading than IH and the two hybrids Further, IF was found to grow as well in low shade as in medium shade. Both hybrid taxa were more shade tolerant than IH IH was greatly affected by all levels of shade From this experiment it appears that shade tolerance can only partially explain the distribution and zonation of IH and IF

142

Crooks, Fred B. and James S. Fralish. Southern Illinois University, Carbondale--A comparison of presettlement and existing forest conditions in the Shawnee Hills of Illinois.
Witness tree data from the 1806-7 original land survey records were used to reconstruct forest community landscape patterns in the Shawnee Hills. Section and quarter corners were located on topographic maps and catagorized by site type: south slope, ridgetop, high north slope, low north slope and alluvial. Species basal area and density were calculated for each site. Quercus alba and Q. velutina were found to be the most important species on all sites. Acer saccharum, which presently dominates old-growth stands on mesic low north slopes and alluvial sites, was considerably less important in the presettlement forest. Across comparable sites, the community composition pattern in the presettlement forest was more similar to that of disturbed second-growth forest than to undisturbed old-growth forest found in the Shawnee Hills. Ridgetop sites supported a relatively open, savannah community of large Q. alba and Q. velutina trees; here, Cornus florida frequently was used as a witness tree. Basal areas ranged from 14 to 16 m2/ha for all except the alluvial site which had a basal area of 21 m2/ha.

143

FROST, CECIL C. and ALLEN E. PLOCHER. University of North Carolina and Old Dominion University--Restoration of fire communities on a preserve in southeastern Virginia.
Pyrophytic communities once formed the dominant vegetation of 5 counties in southeastern Virginia and were a major component of at least 7 more. The original range of longleaf pine may have extended as far north as the Maryland border, but commercial exploitation, beginning with export of 40 barrels of tar from John Smith's settlement at Jamestown in 1608, led to decimation of the species by 1840. A single preserve exists for protection of longleaf and associated fire communities in the state. The Blackwater Ecologic Preserve contains remnants of several fire vegetation types and is the northern outpost of a number of savanna herbs disjunct from their southern counterparts by more than 200 km. Restoration of the mosaic of original natural communities, which may have included longleaf pine-turkey oak woodland, longleaf pine savanna, pond pine pocosin and canebrake, began in 1986. A winter burn resulted in the following stem mortality: Longleaf pine, 2%; turkey oak, 5%; loblolly pine, 42%; pond pine 57%. Fire effectively removed the litter layer but left intact a 3.25 cm humic layer with a dense mat of shrub rhizomes. A summer burn killed some trees in larger size classes and removed the humic layer in patches. Further results are presented on winter and summer burns, the first in more than 30 years.

144

KLIMAS, CHARLES V. US Army Engineer Waterways Experiment Station, Vicksburg, MS--Forest degradation and preservation in a developed landscape.
The Lower Mississippi Valley has been the focus of flood control and agricultural development efforts on a massive scale. The result has been deforestation of most of the historic floodplain, with the remaining tracts scattered in small blocks or forming corridors along rivers. About a fourth of the remnant forest (over one million acres) is confined within the mainstem levee system of the Mississippi River, where it forms a nearly continuous corridor for 600 miles from the Ohio River to the Gulf of Mexico. Although much of this forest is of low quality, its relative scarcity and unique spa-

tial arrangement make it increasingly valuable as habitat for migrating, wintering, and resident wildlife. The isolation of the system and frequent perturbations contribute to both its preservation and its tendency to remain in a degraded condition.

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MCGUIRE, ROBERT F. University of Montevallo--Numerical taxonomic investigations of selected filamentous non-heterocystous Cyanobacteria.

Forty-two strains of filamentous non-heterocystous Cyanobacteria (Cyanophyta) were investigated by using 23 characters from previously published literature. The strains which are known to divide in only one plane have been assigned to Spirulina, Oscillatoria, Pseudanabaena, and the LPP group (containing among other genera Lyngbya, Phormidium, and Plectonema). Several of the strains within the LPP group are without clear generic assignments. The problem was to determine if these 23 characters would be sufficient to clearly cluster and separate the 42 strains into generic groups by numerical taxonomic methods and to investigate the clustering of the LPP group. Character states were assigned to each character for each strain; simple matching coefficients were calculated and these converted into Euclidean Taxonomic Distances for construction of a dendrogram. Within the dendrogram, the 2 Spirulina, the 8 Oscillatoria, and the 7 Pseudanabaena strains clustered independently and within their respective genera. At least five generic groups seem likely within the LPP cluster; these are 2 marine strains of Phormidium 1 strain of Lyngbya, 9 strains of Azolla(?), 12 strains of Plectonema(?), and one unnamed strain sufficiently removed to be assigned to an independent genus.

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KELLER, HAROLD W. The University of Texas at Arlington--A new species of Physarum (Physaraceae, Physarales, Myxomycetes) with wrinkled-reticulate spores.

This taxon was initially collected August 15, 1968 from the scattered remains of a decomposing alfalfa stack at the experimental poultry facility near Kansas State University. Since that time it has been cultured many times from spore to spore on sterilized bovine dung and on agar culture under laboratory controlled conditions. This taxon typically forms white plasmodiocarps varying from elongate and terete to pulvinate and cerebriform up to 4 mm in length, or sometimes sessile sporangia. The white calcareous peridium is smooth to rugulose usually distinctly separated from a membranous, iridescent inner layer. The capillitium is abundant consisting of a network of hyaline threads interconnected by white angular or irregular lime knots. A massive lobed, calcareous pseudocolumella often fills the center of the fructification. The spores are black in mass. When seen by transmitted light the spore is paler and smooth on one side, otherwise the spore surface becomes wrinkled after drying giving a reticulate appearance. A white phaneroplasmodium was observed in agar culture. The conspicuously wrinkled-reticulate spores serve to distinguish this taxon from all other species of Myxomycetes.

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WALLACE, JAMES W., AND SUSAN L. STRUM. Department of Biology, Western Carolina University, Cullowhee, NC 28723 - Flavonoids of Psilotum (Psilotaceae).

The polyphenolic components of the New Zealand species Psilotum nudum, Tmesipteris tannensis and T. elongata have been used to differentiate the Psilotaceae from the putatively primitive leptosporangiate ferns; Stromatopteridaceae, Gleicheniaceae, and Schizeaceae. The current report concerns the identification of the polyphenolic profiles of an additional population of P. nudum from New Caledonia, P. flaccidum from New Guinea, and the putative hybrid P. complanatum from Hawaii. The profiles of these additional species are similar to those published for P. nudum, T. tannensis and T. elongata. The biflavone, amentoflavone, and its O-glucosides were the dominant compounds detected with minor amounts of flavone-O-glycosides based on apigenin. Other flavonoid types were not detected. The current data support the conservative polyphenolic nature of the Psilotaceae as compared to the chemically distinct profiles of the filicalean ferns.

148

DAVENPORT, L. J. Samford University--The Lemnaceae (duckweeds) of the southeastern United States.

Following extensive field work and examination of herbarium specimens, a treatment of southeastern Lemnaceae has been prepared. Included are two species of Spirodela (S. polyrrhiza, S. punctata), six species of Lemna (L. perpusilla, L. aequinoctialis, L. obscura, L. minor, L. valdiviana, L. minuscula), two species of Wolffia (W. brasiliensis, W. columbiana), and three species of Wolffiella (W. lingulata, W. oblonga, W. gladiata). The distributions of these species in the southeastern United States, as well as problems with their identification and nomenclature, will be discussed.

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MATTHEWS, JAMES F., JAMES R. ALLISON and WAYNE R. FAIRCLOTH. University of North Carolina at Charlotte, Lawrenceville, Georgia and Valdosta State College--A Portulaca species new to the United States.

In preparing the treatment of the genus Portulaca for the Southeastern Flora, a specimen [P. smallii P. Wilson, Georgia: Coffee Co., 3 Aug. 1970, Faircloth 6773 (VSC)] could not be identified. Subsequent interest by the second author has allowed a tentative identification of the specimen as P. biloba Urban. This species was described from material collected by Dr. E.L. Ekman in 1924 in the Camaguey province of Cuba. In more recent floras it has not been reported from any locality outside of Cuba. Confusion as to the acceptance of this name results from Legrand's 1962 treatment in which he synonymized P. biloba with P. teretifolia var. cubensis (Urb.) Legr. Since the 1970 report of the species from a single sandstone outcrop in Coffee Co., it has spread successfully to three sandstone (Altamaha Grit) outcrops in Coffee and Jeff Davis Counties. Correspondence with those preparing the Flora of Cuba has attempted to clarify the nomenclature and its current distribution in Cuba. A detailed analysis of the habitat in Georgia will be presented, along with a characterization of its irregular flowering cycle, apparently related to sunlight and humidity. Comments will be made on its possible means of introduction into the United States.

150

LIEVENS, ALAN W. and LOWELL E. URBATSCH. Louisiana State University--The Indigofera miniata Ortega complex (Fabaceae) in Texas.

Indigofera L. in North America is represented by approximately 50 species segregated into twelve infrageneric taxa. One of these, the Leptosepalae with eight species, has been noted to present taxonomic difficulties because of morphological similarities and apparent intergradation among some of its members. The first described and most widespread species is I. miniata. Noting the taxonomic difficulties, B. L. Turner reduced two species to varietal status, thus recognizing in Texas one widely distributed species, I. miniata, with three varieties. The typical variety is reported from south Texas, var. texana is from the Central Mineral Region, and var. leptosepala is from north and central regions. In re-examining the status of these taxa, a number of herbarium specimens have been measured or scored for various morphological features. Computer-assisted algorithms (including principal components analysis and canonical variates analysis) are being employed to analyze the data. Preliminary observations suggest that two broad groups exist--one widespread from throughout parts of the range and the other from the Central Mineral Region. The population in the Central Mineral Region, corresponding to var. texana, appears to be reasonably well differentiated from the other population.

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MURRELL, ZACK E. Dept. of Botany, Duke University--A phylogenetic analysis of the genus Cornus (Cornaceae).

Cornus is a large genus with centers of diversity in the temperate regions of Asia and North America. The sixty species in the genus have been variously divided into subgenera or segregate genera, but much of this effort has been based upon an imperfect understanding of inflorescence structure. Observations of the developing inflorescence have shown that the subgenus Kraniopsis is not ebracteate, as indicated by Hutchinson (1942), but possesses small, ephemeral bracts. Several workers have presented schemes of hypothetical evolutionary relationships within Cornus, although no cladistic analyses have been completed. Using morphological, micromorphological, chemical, and architectural characters, subgeneric relationships within Cornus have been evaluated and a phylogenetic hypothesis of relationships has been constructed. The data were analysed using the Fortran 77 program PAUP (Phylogenetic Analysis Using Parsimony) (Swofford 1984), and the trees were compared to existing hypotheses of relationships. Bract size, fruit pigments, and inflorescence structure were critical characters in the analysis. The results suggest that the large-bracted herbaceous subgenus, Arctocrania, is more closely related to the subgenera Kraniopsis and Mesomora than to the other large-bracted subgenera. This scheme of relationships will be used for outgroup comparison in an ongoing study of the small-bracted subgenera, Kraniopsis and Mesomora, at the species level.

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COX, PATRICIA B. and LOWELL E. URBATSCH. Louisiana State University--A Phenetic analysis of the Rudbeckia nitida Nutt. complex (Asteraceae: Heliantheae).

Rudbeckia L. sect. Macrocline T. & G. contains eight species having a base chromosome number of $x=18$. Within the section, taxa comprising the R. nitida complex besides the typical variety include, R. auriculata, R. maxima, R. nitida var. texana, and R. scabrifolia. Each has a restricted geographic distribution in the southeastern United States. A series of phenetic analyses were performed to evaluate the status and relationships among the taxa of the complex. Seventeen characters were chosen for morphometric analysis. The analyses included univariate (General Linear Model Procedure) and multivariate (Principal Component Analysis and Canonical Discriminate Function) programs in SAS. In the NTSYS software package Gower's Coefficient and the UPGMA clustering algorithm were performed. Preliminary results support recognition of the five taxa. The two varieties of *R. nitida* show the greatest degree of similarity, *R. auriculata* and *R. scabrifolia* show considerable affinities, and *R. maxima* is distinct.

153

BOUNDS, RICHARD R. Mount Olive College--*Patterns of isozyme variation in Iliamna corei (Sherff) Sherff.*

Iliamna corei, Peters Mountain Mallow, has been called "America's rarest plant." Since its discovery by Earl Core in 1927 it is known from one location in Giles Co., Virginia. Estimated as comprising no more than fifty plants in scattered clumps, it was originally thought to be a new station for *Iliamna remota* Greene. In June 1987, *I. corei* comprised three clumps or purported clones, with clone one having an estimated four individuals, clone two with an estimated four individuals and clone three of one individual. In collaboration with a recovery project for this species, this preliminary survey of patterns of isozyme variation utilized leaf extracts from five individuals. Additionally, a population of *I. remota* from Botetourt Co., Virginia, has fourteen individuals sampled. Eleven enzymes were electrophoretically assayed, employing five buffer systems. Apparent polymorphisms in the populations of both taxa were detected in five enzymes (G6PDH, IDH, LAP, MDH, PGM) with inter-clonal variation detected in *I. corei*. These results further indicate some apparent differences in loci between *I. corei* and *I. remota*.

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FLORY, WALTER S. and GERALD L. SMITH. Wake Forest University--*A chromosome classification for the Zephyrantheae.*

Zephyranthes Herb., an American genus of some sixty species in the Amaryllidaceae, is distributed in the warmer parts of the Americas and the Neotropics. Biosystematic studies of taxa in the genus and those in allied genera (e.g. *Habranthus*, *Sprekelia*), undertaken by us and our associates, have shown that both interspecific and intergeneric crosses have produced numerous hybrid progeny. Analyses of parental and hybrid karyotypes have resulted in the development of a simple, widely adaptable, chromosome classification - one having widespread application in determining taxonomic affinities and evolutionary patterns in the Zephyrantheae.

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EVANS, DAN K. and JOAN B. ESTEP. Marshall University--*The origin and status of Carex xdeamii Hermann.*

The paternal parent of *Carex xdeamii* has been uncertain since the sterile hybrid was named in 1938. The maternal parent, established by morphological characteristics, is *C. shortiana* (section *Shortianae*). The two most likely candidates for the paternal parent are *C. typhina* and *C. squarrosa* both in section *Squarrosae*. F. J. Hermann, author of the hybrid, favored *C. typhina* but with reservations. Others have questioned his decision. This study involving morphometrics, chromosome study and leaf anatomy, indicates that *C. xdeamii* is indeed the product of the cross between *C. shortiana* (maternal) and *C. typhina* (paternal).

156

DEBIASE, ADRIENNE E.[1], ROBERT W. SANDERS[2], and KAREN G. PORTER[2]. Savannah River Ecology Lab[1] and the University of Georgia[2] --Relative nutritional value of algal and protozoan food sources for *Daphnia*.

The relative importance of autotrophic green and golden-brown flagellates, desmids, cyanobacteria, and ciliates as food for Cladocerans was examined using cohort life tables with *Daphnia magna* as the test animal. Each cohor was fed a single food type at a given concentration, and comparisons among each type were made. Growth, reproduction, and survivorship of *D. magna* were highest when the green flagellate, *Chlamydomonas reinhardii*, or the golden-brown flagellate, *Cryptomonas* sp. were the food source. Cohorts fed the cyanobacterium, *Microcystis aeruginosa*, had poor growth and survivorship with no reproduction. The desmid, *Staurastrum* sp., and the ciliate, *Cyclidium* sp., produced intermediate growth and survivorship. *Daphnia* fed *Staurastrum* produced few young, while those fed *Cyclidium* did not reproduce at all. The animals grew and reproduced when fed the ciliate *Paramecium caudatum*. Eggs were produced, but all were aborted after two or three days. The results suggest that the cryptophytes and green algae are very important food sources for cladocerans, while ciliates and cyanobacteria are poor as a sole source of nutrition. They also suggest that ciliates may be an unimportant means by which bacterial production flow to the higher trophic pathways in planktonic food webs.

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PRIDE, THOMAS E., WINSTON PAUL SMITH and MICHAEL J. HARVEY. Tennessee Technological University--*Determination of sample size for analysis of species diversity indices.*

In studies of community ecology, adequate sample sizes are necessary to achieve desired precision. This paper describes an example of sample size determination in analyses of aquatic communities using the following formula: $n = (t^2 s^2 F)/d^2$, where *t* is the critical value (two-sided) with a given α and d.f., *s^2* is an estimate of variance, *F* is the critical value (one-sided) for a given β for *n*-1 and an estimated number of observations required as d.f. for denominator and numerator, respectively, and *d* represents the level of acceptable error, i.e., one-half the desired maximum confidence interval. Preliminary sampling of aquatic invertebrate fauna at four sites yielded 79 organisms distributed among six taxa. Shannon diversity indices were computed with the formula: $H' = (n \log n - \Sigma f_i \log f_i)/n$. Values ranged 0.324-0.543 with a weighted mean of 0.415. Variance of each index was estimated by: $s^2 = \{\Sigma p_i \log^2 p_i - (\Sigma p_i \log p_i)^2/n\}/n^2$. The estimate of variance for sample size determination was derived from a pooled estimate of variance computed for the samples according to the equation: $s^2_p = \Sigma(n_i-1)s^2_i/N-k$ where k is the number of samples. According to the variation observed in the preliminary samples, the sample size required to obtain estimates of species diversity with a 90% probability (β) that the 95% (α) confidence interval will not exceed 0.0415 (0.1 of the weighted mean) is 7.5. This technique provides an estimate of sampling intensity sufficient to accomodate natural variation and/or other sources of error inherent in studies of biotic systems.

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MAHONEY, DIANE L., MONA A. MORT, and BARBARA E. TAYLOR. Savannah River Ecology Laboratory--*Zooplankton are diverse in Carolina Bays.*

We sampled twenty-three freshwater Carolina Bays on the Savannah River Plant in South Carolina for zooplankton in 1987. Samples were taken in each bay in February, April, and June. The zooplankton were diverse: for example, more than forty cladoceran species were present, and some samples contained nearly twenty cladoceran species. Some taxa were widely distributed, such as *Simocephalus serrulatus* and *Chydorus* spp., while others were present in just a few bays. Most of the larger species, including Conchostraca, Anostraca, and calanoid copepods such as *Diaptomus stagnalis*, were present only early in the wet season. These species completed one generation and produced only resting eggs. Smaller species, particularly chydorid cladocerans, were most common later in the season. Many of the bays dry up annually. The length of time a bay holds water strongly influences the composition of the zooplankton community.

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TURNER, M. RANDALL[1], HAZEL R. DELCOURT[2], PAUL A. DELCOURT[2], and FREDERICK W. HARRISON[1]. Western Carolina University[1] and University of Tennessee, Knoxville[2]--*Paleolimnological and paleoecological study of Jackson Pond, Kentucky utilizing fossilized remains of freshwater sponges.*

Jackson Pond lies 190km south of the full-glacial ice margin. Freshwater sponge spicules were found throughout the Jackson Pond sediment profile from 20,000 years B.P. During the full-glacial and late-glacial intervals the dominant sponge species was the cold-water sponge *Heteromeyenia latitenta* which declined during the early Holocene and disappeared during the warm, dry mid-Holocene. *Ephydatia fluviatilis* co-existed with *H. latitenta* and persists. Between 8,000 and 7,000 years B.P., *Anheteromeyenia ryderi* colonized Jackson Pond. *Spongilla lacustris* populated the pond within the past 500 years. Warmer, drier mid-Holocene climates lowered water tables, probably decreased siltation, and allowed the development of a littoral vegetative thicket screen in the pond. Turbidity-inhibited *A. ryderi* populations flourished while turbidity-tolerant *E. fluviatilis* populations decreased significantly. Warm, moist late-Holocene climates elevated water depths and reduced the effectiveness of the littoral swamp/thicket barrier in filtering out mineral sediment. *Ephydatia fluviatilis* again became the dominant species in the pond. The relative distribution of these species of freshwater sponges from 20,000 years B.P. in Jackson Pond reflects the same long-term changes in microclimate, water quantity and habitat shifts as independently indicated by bottomland swamp/thicket and aquatic plant assemblages.

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MATTHEWS, KIMBERLY and DONALD TARTER. Marshall University--*Ecological life history, including laboratory respiratory studies, of Ameletus tarteri Burrows in Carpenter Run, North Fork of Cherry River, West Virginia (Ephemeroptera: Siphlonuridae).*

The ecological life history of the mayfly *Ameletus tarteri* Burrows was studied in Carpenter Run, a tributary of the North Fork of the Cherry River, Greenbrier County, West Virginia from November 1986 to November 1987. *Ameletus tarteri* is known from West Virginia, Virginia and New York. Nymphs are usually found in rocky first and second order streams. These streams typically have low pH, low alkalinity and low specific conductivity. The following ecological and physiological components will be discussed and compared to other *Ameletus* species: foregut analysis, growth, sex ratio, emergence period, fecundity, egg morphology and oxygen consumption rates.

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GLOVER, JAMES and DONALD TARTER. Marshall University--*Emergence patterns of leptocerid caddisflies from West Virginia (Trichoptera: Leptoceridae).*

In West Virginia, the family Leptoceridae contains six genera (*Ceraclea*, *Mystacides*, *Nectopsyche*, *Oecetis*, *Setodes*, *Triaenodes*) and 19 species. Adults were collected with a black light trap from the seven major watersheds in the state. The emergence period extends from 14 May to 17 October. Linear regression analysis was used to determine the relationships between elevation and adult phenology of selected leptocerid species. These relationships will be discussed and compared to leptocerid species throughout the entire range.

162

MILLER, ANDREW C.,[1] and PAUL D. HARTFIELD.[2] US Army Engineer Waterways Experiment Station[1] and Mississippi Museum of Natural Science[2]--Characterization of a dense mussel bed in the Sunflower River, Sharkey Co., Mississippi.

An evaluation of the condition of a mussel bed should be based upon measurements of species richness, relative abundance, density, and recruitment. In October, 1987, 30 total substratum samples for freshwater mussels (Mollusca: Unionidae) were obtained from a dense bed in the Sunflower River, a low gradient, turbid river with sand/silt substratum. Fourteen species, including the Asiatic clam *Corbicula fluminea*, were found in the quantitative samples, and an additional 11 species were obtained in qualitative collections. The fauna was dominated by *Amblema plicata* and *Plectomerus dombeyanus*, which comprised 70.8 and 13.6% of the community, and 78.1 and 13.4% of the biomass, respectively. Density ranged from 32.0 to 94.0 individuals per sq m (Ave = 83.6, SD = ± 25.9), and total biomass ranged from 1103.3 to 7092.0 gm/sq m (Ave = 3554.0, SD = ± 1557.7). Evidence of limited recent recruitment was found for seven species. Although this bed was characterized by comparatively low species richness and little recent recruitment, the high densities and biomass illustrate the value of this reach of the Sunflower River for freshwater mussels. This research was supported by the Environmental Impact Research Program of the US Army Engineer Corps of Engineers.

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WILLIAMS, JAMES D. and DAWN P. JENNINGS. U.S. Fish and Wildlife Service--Preliminary observations on the exotic fishes of the Indian River system, Florida.

The Indian River system, located on the east coast of Florida, is a 253 km long, narrow estuarine lagoon system. During the past 15 years, 10 species of exotic fishes have been reported from the system. These include one species of catfish (*Clarias batrachus*), three species of livebearers (*Xiphophorus helleri*, *X. maculatus*, and *X. variatus*), and six species of cichlids (*Cichlasoma octofasciatum*, *Hemichromis bimaculatus*, *Tilapia mariae*, *T. melanopleura*, *T. melanotheron*, and *T. mossambica*). Past and present distribution of each species within the Indian River system will be reviewed, and current status of each population (established vs present but not established) will be examined. Life history and habitat requirements in relation to dispersal potential will be discussed.

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THOMPSON, BRUCE, JEFFREY RENDER, GARY PETERSON. Louisiana State University, W. WAYNE FORMAN. Freeport McMoran, Inc.--Preliminary information on fishes of Louisiana's barrier islands.

Barrier islands are dominant geological features along many coastlines throughout the world. Some coastlines are nearly completely lined with a chain of these islands, providing substantial habitat for many fish species. Ross (1983) reviewed the ichthyofauna of Gulf of Mexico barrier island beaches, but provided no information from Louisiana. Laska (1973) reported 101 species from various habitats on the Chandeleur Islands. We have recorded 83 species from Grand Isle and 83 species from Isles Dernieres based on seine and poison samples taken between 1972 and 1987. Dominant families in the Louisiana barrier island fish assemblages are: Sciaenidae, Carangidae, Gobiidae, Bothidae, and Cyprinodontidae. Interesting records from the barrier island system include: *Echiophis punctifer* (Stippled Spoon-nose Eel), *Albula vulpes* (Bonefish), *Micrognathus crinigerus* (Fringed Pipefish), *Gunterichthys longipenis* (Gold Brotula), *Seriola rivoliana* (Almaco Jack), *Erotelis smaragdus* (Emerald Sleeper), and *Paralichthys squamilentus* (Broad Flounder). Island beach and marsh habitat are valuable nurseries for estuarine, migratory estuarine-marine and many marine fishes. In Louisiana, the barrier island sand beaches provide the main nursery habitat for such species as *Menticirrhus littoralis*, *Trachinotus carolinus* and *T. falcatus*. Barrier island habitat is being altered and/or lost in Louisiana at a rapid rate and information on the fish assemblages using these islands needs to be synthesized.

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MITCHELL, MICHAEL E., KRISTIE A. KILLAM, RANDALL J. HOCHBERG, and ROBERT H. MCMICHAEL, JR. Florida Department of Natural Resources, Bureau of Marine Research--Gear development for a long term juvenile fish monitoring program in Tampa Bay Florida: Trawls.

Efficacy of two types of trawls were tested as part of the development of a long-term juvenile fish monitoring program of the Tampa Bay estuarine system. This report compares day and night sampling from a pair of 1.5 m roller frame trawls towed abreast and a 6.1 m otter trawl, both constructed with 3.2 mm mesh liners to capture juvenile and larger post-larval fish. Pilot sampling determined optimum towing speeds, and distances. The sampling site was a uniformly dense *Thalassia testudinum* seagrass meadow. Seventeen species were captured during 12 paired frame trawl tows and twenty-one species were captured in 12 otter trawl tows. Two species were unique to the frame trawls and six were unique to the otter trawls. Daytime frame trawl density estimates were 8.5 fish/haul or 0.06 fish/M^2. Nighttime values were 22.0 fish/haul or 0.14 fish/M^2. Otter trawl density estimates were 59.3 fish/haul or 0.30 fish/M^2 during the day and 31.3 fish/haul corresponding to 0.16 fish/M^2 at night. Additional sampling over various bottom types and conditions will be conducted to evaluate which gear would be a more desirable tool for use in a long term monitoring program.

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KILLAM, KRISTIE A., and RANDALL J. HOCHBERG. Florida Department of Natural Resources, Bureau of Marine Research--Use of portable drop nets in estimating density, diversity, and biomass of juvenile fish and macroinvertebrates in shallow estuarine systems.

This investigation began a long-term study to estimate carrying capacity of fish and macroinvertebrates (Callinectes sapidus and Penaeus duorarum) in seagrass beds. Preliminary sampling was conducted near Tarpon Key, Florida, a small mangrove island located inside Tampa Bay and surrounded by an extensive, homogenous, dense distribution of Thalassia testudinum. Two types of manually released drop nets (3.2 mm mesh) were tested: (1) stationary tripod drop nets in which a single net of 1, 2 or 4m^2 was suspended approximately 1.5 m above the water, and (2) two 1m^2 "roving" drop nets suspended from the bow of a 17' boat. Fourteen fish species were captured during June-September, 1987. Mean density estimates determined for the 1, 2, and 4m^2 nets were 4.6, 6.1, and 6.2 organisms/m^2, respectively. Roving drop nets estimated 6.4 organisms/m^2. Mean diversity estimates for the 1, 2 and 4m^2 nets were 2.9, 3.3, and 3.4 species/m^2, respectively. Diversity for the roving nets was 2.4 species/m^2. Density and diversity estimates per m^2 were markedly greater than those estimated with a 6.1 m otter trawl and a 1.5 m roller trawl, although actual number of species captured with the trawls was greater. Mark-recapture techniques were utilized to determine efficiency of removal of organisms from the nets. Efficiency varied with the size of drop nets and was also dependent on species captured. Further sampling will be conducted near Cockroach Bay where preliminary samples with the roving drop nets suggest a greater faunal diversity than Tarpon Key.

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MCMICHAEL, ROBERT H., JR. Florida Department of Natural Resources, Bureau of Marine Research--Population dynamics of red drum (Sciaenops ocellatus) in a small canal off the Alafia River, Tampa Bay, Florida.

Population dynamics of young-of-the-year red drum (Sciaenops ocellatus) were studied for two years in a small (.76 ha) canal off the Alafia River, Tampa Bay, FL. Standing crop in the canal was estimated by two different methods, one based on the number of fish caught/m^2 and the other by mark-recapture ratios. Both methods yielded similar results. Standing crop ranged from less than 100 during the summer to over 2000 during December and January. Recruitment into the canal started in October and continued into December. Longest residency, obtained from monitoring marked fish, was 162 days with no marked fish being found in the canal after May. Stop nets were positioned at the mouth of the canal to monitor immigration and emigration every three hours over a 24 hour period, bi-weekly, during the first year and weekly during the second year. Greatest movement, both into and out of the canal, occurred during the winter coinciding with times of greatest standing crop, coldest temperatures, and lowest water levels. These data will be compared to data obtained from this canal subsequent to release of hatchery reared fish. This exercise will simulate a large scale release of hatchery reared fishes to a natural system and attempt to determine the potential outcome.

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HASTINGS, ROBERT W. Southeastern Louisiana University--Seasonal recruitment patterns of bay anchovy (Anchoa mitchelli) into the upper Lake Pontchartrain estuary.

The fish fauna of Lake Maurepas in the oligohaline upper Lake Pontchartrain estuary is characterized by a large marine component dominated by the bay anchovy. Most marine species are seasonal, and leave the estuary for the gulf during the winter. Recruitment of bay anchovy into the upper estuary occurs primarily in March when juveniles and small adults (mostly 25-50 mm Standard Length) move into the area. Spawning occurs within the estuary and prejuveniles (9-17 mm Standard Length) appear in June. Both groups leave the upper estuary in December.

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SCHWARTZ, FRANK J.[1], JAMES TYLER[2], AND SUZANNE HILL[2]. Institute of Marine Sciences, University of North Carolina[1], and N.C. Division of Marine Fisheries[2]--Massive migratory congregations of the cownose ray, Rhinoptera bonasus off North Carolina and of rhinopterids worldwide.

Five species of cownose rays, genus Rhinoptera, frequent temperate and tropical waters of the world. Massive schools or congregations have been sporadically noted for R. bonasus, R. javanica, and R. steindachneri. Dense R. bonasus schools were observed moving along the Sarasota, Florida, Gulf of Mexico Coast toward Yucatan, Mexico in 1963 and in Chesapeake Bay or southward along the Delaware-Maryland-Virginia coasts in 1962-1964. Since then little has been recorded regarding large migratory aggregations of R. bonasus anywhere. Massive schools of R. bonasus, 6-7 each year, were sighted off Core and Shackleford Banks, NC during their fall, southerly migration in September 1985 and

1986 respectively. Each school, occupying 2.4-4.0 hectares, consisted of hundreds of thousands of rays often layered 6-10 rays deep. Schools usually frequented coastal waters 0.25-10.5 m deep. Layering extended from the ocean surface to the substrate, as evidenced by a trail of disturbed substrate. To date large scale schooling is known only for R. steindachneri from the Pacific Galapagos Islands (in 1978) and R. javanica, on five occasions (1899-1973), between Sri Lanka (Gulf of Mannar) and Madras (Bay of Bengal) off eastern India. Whether R. marginata of the Mediterranean and West African coasts, R. neglecta off eastern Australia or R. javanica, in other parts of its Indopacific range, school is unknown.

170

JOY, JAMES E. Marshall University--Monthly length class frequencies of *Microcotyle spinicirrus* (Monogenea: Microcotylidae) from the freshwater drum, *Aplodinotus grunniens*, in West Virginia.

The gills of 173 freshwater drum, *Aplodinotus grunniens* Rafinesque, taken from two locations on the Kanawna River, West Virginia, were examined for the monogenetic trematode, *Microcotyle spinicirrus* MacCallum. A prevalence of 81.0% was recorded for hosts at Winfield, and 75.4% at Marmet. Intensity of infection, as mean number of *M. spinicirrus* individuals per infected host, for drum at these two locations was 3.5 and 8.7, respectively. Larger hosts generally carried more *M. spinicirrus* individuals than smaller ones. Large (> 5.0 mm) *M. spinicirrus* individuals dominated the May sample, while smaller length classes of this monogenean were dominant from June through October of 1986.

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JOY, JAMES E. and ELIO MADAN. Marshall University--Larval tapeworm infections in largemouth and spotted basses taken from Beech Fork Lake, West Virginia.

Possible causes for apparent low catch rates of native basses in Beech Fork Lake, a small (900 acres) U. S. Army Corps of Engineers impoundment in Southwestern West Virginia, were sought. In a preliminary investigation the livers of 56 bass--24 largemouth, 23 spotted, and 9 hybrid--were examined during July and August of 1987 for pleurocercoids of the bass tapeworm, *Proteocephalus ambloplitis* (Leidy, 1887). Prevalence rates of pleurocercoids for the two species of native basses, *Micropterus salmoides* and *M. punctulatus*, were very high at 83.3% and 91.3%, respectively. The mean intensity, as number of pleurocercoids per infected host liver, was 16.7 for largemouth, and 8.7 for spotted basses. No hybrids (*Morone chrysops* x *M. saxitalis*) were infected. Numbers of pleurocercoids in livers were negatively correlated with increasing total body length in both host species (r = -0.633 for largemouth, and r = -0.211 for spotted). Pleurocercoids replaced 50% to 60% of the liver parenchyma. Liver parenchyma adjacent to pleurocercoids showed varying degrees of necrosis and minimal fibrosis. No bile-stasis was present in hepatocytes or bile ducts, nor was there any evidence of bile duct proliferation. Investigation supported by U. S. Army Corps of Engineers, Huntington, W. Va. District, Contract #DACW69-87-M-1850.

172

PORCH, JOHN R. Auburn University--Acarine parasites of the cattle egret (Bubulcus ibis ibis) in Alabama.

Two mite species were collected from cattle egrets in Alabama during a general parasite survey. Adult nasal mites, Tinaminyssus bubulci Zumpt and Till (Rhinonyssidae), were found in the nasal passages of 69/190 birds (36.3%). The accumulation of bloody mucous was the only apparent host response to the presence of these mites. Mature hypopi of the subdermal mite Hypodectes propus bubulci Fain were collected from loose connective tissue in the axillary, inguinal, and cervical regions of 92/190 birds (48.4%). Histologic sections showed a host response consisting of slight inflammation and encapsulation of the parasite. Although the hypopi lack functional mouthparts, they can apparently absorb lipids through their cuticle while in the host.

173

ROBINSON, KENT. Appalachian State University--Marianne North (1830-90), botanic artist and confidant of Charles Darwin.

The Royal Botanic Gardens at Kew in London, England has granted permission to present copies of botanic art from the Marianne North Gallery. Miss North, a middle-aged Victorian English lady, in 1871 started her first expedition to make a pictorial record of tropical and exotic plants of the world. Her work impressed scientists of the day and some of her friends who became our human icons of science are: Asa Gray, Sir Joseph Hooker, Alfred Russel Wallace and Charles Darwin. The scientific community honored her with the following: Northea sechellana, Nepenthes northiana, Kniphofia northiae and Crinum northianum. Marianne North's love for detail preserved images of many tropical habitats long since lost to exploding populations. Her over 800 paintings at Kew can still be seen as she presented them over 100 years ago. Charles Darwin, a special friend, asked Miss North to go draw the unique plants of Australia. When she returned she visited the Darwin home and let her art become a vicarious second voyage on the Beagle shortly before Darwin died.

174

THOMAS, R. DALE AND CHARLES M. ALLEN, Northeast Louisiana University and Louisiana State University at Eunice---A status report on the Flora of Louisiana Project.

The project to write a flora of Louisiana was begun in 1966 and it continues. Checklists of the woody plants, the dicotyledons, and the monocotyledons, pteridophytes, and gymnosperms have been finished. Family studies have been made for Poaceae, Asteraceae, Cuscutaceae, Fabaceae, Onagraceae, Orchidaceae, and Scrophulariaceae. An atlas of the distributions of all the vascular species within the state is in progress. Checklists of the vascular plants of 36 of the 64 parishes in the state have been completed. A manual of the vascular plants is planned and help with any of the groups is solicited.

175

SOBLO, DALE C. AND JOHN E. FAIREY, III Clemson University--*The Flora of Givhan's Ferry State Park.*

A survey of Givhan's Ferry State Park was started in April of 1987 and continues. Funding for this flora and the flora of Stoney Creek Wildlife Sanctuary is being provided by the South Carolina Department of Parks, Recreation and Tourism. The park is in Dorchester and Colleton counties, South Carolina and covers 400 hectares. The broad floristic habitats contained in the park are (1) Flatland Coastal Plain Province and (2) Alluvial Floodplains and River Terraces Province. Cypress-tupelo swamps dominate the Blackwater River Floodplain of the Edisto river. On the higher sandy terraces *Pinus glabra* forms thick stands with *Quercus lyrata*, *Q. virginiana*, *Q. nigra* and other hardwoods. The Coastal Flatwoods Region covers 320 hectares of poorly drained fine-loamy soils. This area is dominated by *Pinus taeda* and *P. palustris.* The cutover areas of this forest support species characteristic of pine savannahs, e.g. *Sarracenia minor*, *Arnica acaulis* and *Drosera leucantha*. On some of the most elevated and oldest marine terrace deposits are groves of *Fagus grandifolia* and seepage bluffs. The marl seepage bluffs are an ephemeral habitat for calciphiles, e.g. *Adiantum capillus-veneris* and *Thelypteris kunthii*. As of November 1987, 270 species have been identified from this unique park.

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FAIREY, JOHN E., III, CAROLINE C. DOUGLASS ALDRICH, AND STEVEN R. HILL. Clemson University--*Success of Transplants from the basin of the Richard B. Russell Lake.*

Plants of three species, *Trillium cernuum* L., *Panax quinquefolium* L., and *Aruncus dioicus* (Walt.) Fern., considered to be rare in South Carolina were transplanted upslope at the Richard B. Russell Lake basin at Deal Creek, Abbeville of the Co. Transplants of these and five additional species were also made at the Clemson University Botanical Garden. A preliminary report was presented at the ASB meetings in April, 1985. Transplants have been monitored for six years. Size, the number of leaves, and reproductive maturity have been used as indicators of success of the various transplants. Of the 12 original clumps of *Trillium* transplanted, only one plant was located in 1987. Four individuals of *Panax* were transplanted and two survive but are depauperate. Five individuals of *Aruncus* were transplanted with four plants now surviving. Of these one shows some growth, while the others are depauperate. These onsite transplants have been largely unsuccessful. In comparison, the same species transplanted to the Clemson gardens generally are more successful and exhibit sustained growth. The droughts of 1986 and 1987, differences in the transplant habitat, animal predation, and trampling by fishermen could be factors in the failure of the onsite transplants. These observations reflect the difficulties inherent in successfully transplanting native species from endangered habitats.

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BLACKWELL, WILL H.,[1] MARTHA J. POWELL,[1] and GEORGE H. DUKES.[2] Miami University (Ohio),[1] and Belhaven and Millsaps Colleges (Miss.)[2]--*Fossil wood in Mississippi gravel deposits.*

Gravel deposits are a significant economic resource to the state of Mississippi. Appreciation has grown that the major deposits of gravels and associated sands represent more or less distinct units (Russell, 1987): (1) the northeastern Mississippi gravels, (2) the loess-belt gravels, (3) southern Mississippi gravels (Citronelle gravels), and (4) Mississippi "Delta" gravels. To an extent, these gravel aggregates have different sources of origin and are not of uniform geologic age. Interest in fossil remains, including fossil plants, in these deposits dates back many years. Berry (1916) described a number of fossil species in the "flora" of the Citronelle, from leaf, twig, seed, and cone remains. However, the striking and abundant fossil type in the Mississippi gravels is fossil (silicified) wood, largely ignored in formal studies. Our collection and study of fossil wood (primarily so far from gravel area #2) has revealed a diversity of dicotyledonous and coniferous woods. Continued investigation of fossil wood in Mississippi gravels has the potential of providing significant information about the Plio-Pleistocene flora, as well as providing additional characterization of the sources of and differences in the major deposits of gravel.

178

PERRY, JAMES W. and CAROLE A. WOODEN. Frostburg State University--Phloem ultrastructure in the shoot of Monotropa uniflora.

Subterranean shoots of the achlorophyllous epiparasite Monotropa uniflora were field collected prior to their elongation and prepared for light and transmission electron microscopy. These shoots are initiated in the growing season prior to their emergence from the soil. Differentiation of the vascular tissue occurs very near the shoot apex. Ultrastructurally, mature sieve elements are distinguished from contiguous parenchyma cells by their thicker walls and the general paucity of cytoplasmic components. Lined by the plasmalemma, they contain mitochondria and parietal stacks of smooth endoplasmic reticulum. In contrast to sieve elements of green plants, plastids have not been observed in Monotropa. Pores are clustered on the end walls, forming sieve plates. Thus the sieve elements are more properly characterized as sieve tube members. Callose is commonly present in varying amounts as wall material lining the pores. Previous light microscopy studies on the aerial shoot indicated the lack of P-protein and the absence of companion cells, features characteristic of most dicotyledons. Fibrillar P-protein has been identified during the current study, although the presence of typical companion cells has yet to be determined. Connections between sieve elements and vascular parenchyma cells consist of pores on the sieve element side and branched plasmodesmata on the parenchyma cell side. Both cell types contain numerous apparently spherical virus particles. Mode of cell to cell transmission of these viruses is yet to be observed.

179

LEVY, FROSTY Dept. of Botany, Duke University--The genetic basis of reproductive incompatibilities in the Phacelia dubia (Hydrophyllaceae) complex.

Phacelia dubia (L.)Trel. is an annual herb composed of three recognized allopatric races and several undescribed races. A complete diallel crossing design, in which individuals and populations were nested within races, was utilized to determine a) the stage at which reproductive incompatibilities are expressed, and b) the genetic basis of these crossing barriers. The rate of pollen tube growth, the number of seeds per capsule, and hybrid fertility were used respectively as pre-fertilization, post-zygotic, and hybrid measures of cross compatibility. Backcrosses of hybrids to maternal and paternal races provided further evidence on the genetics of incompatibility. A nuclear-based barrier exists between some pairs of races; in other cases a nuclear-cytoplasmic interaction underlies the incompatibility.

180

MELLICHAMP, T. LAWRENCE and DEBORAH BROWN WAY. University of North Carolina at Charlotte--Stimulating germination and growth in Sarracenia pitcher plant seedlings.

There are 12 species of Sarracenia native to the southeastern U.S. where they grow in sunny, acidic, moist, nutrient-poor habitats. They are notorious for being inter-fertile and forming hybrid swarms. Efforts to produce hybrid pitcher plants for botanical studies and horticultural breeding programs require knowledge of methods to achieve optimal germination and rapid seedling growth. There is little published data on environmental factors affecting germination and growth of seedlings. Anecdotal observations indicate that stratification is required; and that seedlings benefit from soil-applied fertilizer whereas adults may be harmed. Our experiments show that the optimal stratification period is 6 weeks; that seedlings grow year around, but growth is enhanced by long days; and that seedlings benefit from soil-applied fertilizer at the rate of 1/2 tablespoon 15-16-17 soluble fertilizer per gallon water. After one year (or less), fertilized seedlings may be evaluated for adult characteristics, as opposed to 3 years under typical cultural conditions using sphagnum moss as substrate and city water. Potential cultivars may be isolated sooner, eliminating the need to tie up growing space for so long.

181

HORN, CHARLES N. Newberry College--Variation in floral morphology and reproductive strategy of Heteranthera dubia.

The aquatic perennial Heteranthera dubia shows variation in flower size, extent of cleistogamy, and pollen viability between populations in North America. The flower characters of perianth tube length and perianth lobe length show a general north to south increase in size. The southern most populations of Alabama, Texas and Mexico produce the largest flowers and have been referred to as the species liebmannii. Under controlled conditions larger flowers may be produced with an increased overnight water temperature. Cleistogamous flowers have been produced among all populations observed. These self-pollinating flowers are always produced when they develop 5 cm or more under the water surface. Flowers developing in less than 5 cm of water are not consistantly cleistogamous or chasmogamous. Percent pollen viability varies little from one flower to another in an individual clone, but varies from 0% to near 100% from one site to another. No correlation between habitat and pollen viability has been realized.

182

WARE, DONNA M. E. College of William and Mary--Demographic studies of the small whorled pogonia, Isotria medeoloides (Pursh) Raf., in Virginia.

Searches for Isotria medeoloides, a native terrestrial orchid federally listed as endangered, resulted in the discovery of six new populations on the Coastal Plain of Virginia, and the rediscovery of the historic Grimes station. These colonies occur in an apparently unspecialized habitat (open, upland hardwood stands). Demographic studies were undertaken because little is known about the population ecology of this species, especially in the southern part of its range. C-1, the largest colony, had 139 plants in 1987; H-1, second largest, had 22. Based on data taken 1985-1987, 63-73% of the plants of C-1 are vegetative, in contrast to 17-23% for H-1. Long-term monitoring will be necessary to determine whether this differential is largely a function of enhanced recruitment in C-1, or of the failure of mature plants to flower. The habitat of C-1 has higher forest density and ground vegetation coverage values, and the presence of certain herbaceous plants indicates a more mesic environment possibly more amenable to seedling recruitment than that of H-1. Stem height and whorl diameter show positive correlation with increased reproductive status (vegetative/ abortive flower/ normal flower/ twin-flowered). Relatively few stems maintained the same reproductive status three successive years. Of a total of 270 loci known to date, about 20% have failed to reappear during a subsequent growth season. In fewer than five cases have plants reappeared after being absent at least a year.

183

WOFFORD, B. EUGENE and RONALD W. JONES. University of Tennessee, and Eastern Kentucky University--Fimbristylis perpusilla Harper from the Cumberland Plateau of Tennessee.

Fimbristylis perpusilla Harper, a rare southeastern U. S. sedge, is now known from a total of nine counties within six states. This report from Franklin Co., Tennessee represents a Coastal Plain disjunction of ca. 240 miles and the first report from the Cumberland Plateau. Recent collection data indicate that this taxon is becoming widely dispersed and more common. It appears to require a sandy or fine textured substrate that is seasonally inundated, thus eliminating most competitors, yet dry enough during the late summer growing season to allow for germination and establishment. Details of its seed biology and mechanisms of dispersal and establishment are unknown.

184

HERRING, THERESA., ANNE STEVENS AND M. GUNASEKARAN. Fisk University-- In vitro synthesis of amylase in Nocardia asteroides .

Nocardia asteriodes a facultative, intracellular opportunistic aerobic actinomycete infects the immunosuppressed host and causes systemic nocardiosis. This organism is known to produce different hydrolytic enzymes to catabolize the complex store materials of the host for energy production. The present study reports on the in vitro synthesis of intracellular and extracellular amylases in N. asteriodes . The organism was grown in Sabouraud dextrose broth and incubated at room temperature for 72hrs as stationary and shake cultures. After the incubation period, the cells were harvested from the medium and the filtrate was used as the extracellular enzyme source. Cells were washed with Tris HCl buffer (pH 7.00, 10mM) and homogenated with cold mortar and pestle. The cell free extract was centrifuged and the supernatant was used as the intracellular enzyme. Amylase activity was measured by the dinitro salicylic acid method. Specific activity was expressed in micromoles of glucose converted per minute per milligram of protein. Intracellular activity was higher in the shake cultures than stationary cultures. On the other hand, extracellular enzyme activity was higher in the stationary cultures than in shake cultures. Partial purification studies revealed that 40% ammonium sulphate fractions regardless of the enzyme origin, showed the maximum activity.

185

SHARMA, SANJEEV, BARBARA SAMPLES, H. WAYNE ELMORE and MARCIA HARRISON. Marshall University--Affect of cultural and environmental parameters on the stability of ascorbate in plant tissue ulture medium

L-ascorbic acid is frequently included in medium to prevent browning of cultured plant cells, callus or organs even though evidence exists suggesting that it is degraded in aqueous environments. This investigation studied the stability of ascorbate within the milieu of plant tissue culture medium and the rate of destruction as affected by cultural and environmental parameters. Ascorbate was rapidly oxidized in Knudson's, Brown's, and Murashige and Skoog's medium. With 1-2 hrs after preparation of 100 nM/ml solutions ascorbate was destroyed. Autoclaving medium and shaking flasks accelerated decay. A pH range from 4.5 to 7.0 was tested with greater rates of destruction occuring at higher pH's. Sucose, fructose and glucose known to slow oxidation at high concentrations had no significant affect when supplied at concentrations up to 6.0%, often used in culture medium. Light intensity ranging from 0 to 1000 ft. c. did not accelerate destruction. The rapid oxidation of ascorbate suggests that it may not exert its effect directly as an intact molecule. Instead it may be oxidized to dehydroascorbate and then reduced to ascorbate by cultured tissues or alternatively the affects may be mediated by some product of further oxidation. These possibilities are being examined.

186

Bauman, T. R., J. M. Wilman, and E. A. Cross, Jr. University of Alabama--The effects of photo and thermoperiods on the eclosion of Trypoxylon politum.

Diapausing larvae of the common mud-dauber wasp were collected in December and brought into the laboratory. The wasps developed in several combinations of photo and thermoperiods, and their eclosion patterns were recorded. In regimens of constant temperture with constant light or dark, eclosion occurs spread over a twenty-four hour day. Under these conditions, the length of the rhythm controlling eclosion is not exactly twenty-four hours. In regimens of constant temperature, but having a scotopic and photopic phase, eclosion occurs shortly after the begining of the photopic phase. In regimens of constant light or dark, and having two thermoperiods, eclosion occurs shortly after the begining of the higher temperature thermoperiod. In regimens with both photo and thermoperiods, eclosion occurs shortly after the begining of the photophase, even if it coincides with the cooler thermoperiod.

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SEDIVEC, M.J.[1], M.A. DUNNIGAN[1], A.M. KAVOOKJIAN[2], and A.R. LIGHT.[2] Appalachian State University[1] and UNC-Chapel Hill[2]--Local axon collaterals from spinal laminae I and II neurons which project to the brain stem.

Recent studies demonstrate that many nociceptive neurons in laminae I and II have projecting axons terminating in the parabrachial region in the midbrain. Some neurons have local axon collaterals terminating in laminae I, II and in deeper laminae (III, IV, V). We have examined these collaterals with the light and electron microscopes. Single neurons in cat spinal cords were recorded. Nociceptive neurons antidromically activated from the parabrachial region were intracellularly labelled with HRP. The tissue was perfused, removed and postfixed, and sectioned for light microscopy. These neurons were reconstructed with a drawing tube, resectioned for EM analysis, and sections were examined unstained and post-stained. Nociceptive neurons projecting to the parabrachial region were found in laminae I, II. Local axon collaterals from these neurons were found to have "en passant" and terminal varicosities terminating in laminae I, II and continuing deeper to terminate in laminae III, V. These varicosities were small synatpic boutons about 1 μm in diameter. Synaptic boutons were Gray's Type I. They contained clear, round vesicles, a few large dense core vesicles and established one or two asymmetric contacts with dendritic profiles. Results demonstrate that long projection neurons in laminae I, II responding to nociceptive stimulation have local axon collaterals which may be capable of exciting neurons in laminae I-V in the same spinal cord segment. Thus, these neurons may be important in local integration of nociception.

188

BRILEY, GLENN P. AND JOHN A. KNESEL Northeast Louisiana University--Effect of ovulation and pregnancy on oviductal lactate dehydrogenase (LDH) activity in the mouse.

In a series of four replicates, one hundred and twenty eight virgin ICR mice were divided into postovulatory (POV) or pregnant (PREG) groups and each group subdivided by intervals of 12 or 108 hours. All periods were marked from PMSg/HcG-induced ovulation (with PREG mice allowed to mate). At 12 or 108 hours, mice were killed, each oviduct flushed with 0.2 ml cold normal saline, and tissues homogenized. LDH was analyzed using Sigma kit LD-L 228-UV, where one unit of activity = one micromole NADH formed/minute. LDH in oviductal fluid differed significantly ($P<.05$) between 12 and 108 hours within each group but did not differ between groups (POV-12= 24.9 u/1; PREG-12=21.1 u/1; POV-108=12.9 u/1; PREG-108=14.9 u/1). A significant ($P<0.5$) difference was found between tissue LDH in POV-108 (191.1 u/1) and PREG-108 (282.0 u/1) mice while POV-12 (311.3 u/1) and PREG-12 (332.9 u/1) mice did not differ. The results of this study suggest there is increased LDH activity in oviductal fluid coincident with ovulation and early pregnancy and that these levels decrease with time. Also that tissue LDH is initially elevated and decreases in the postovulatory mouse but remains elevated in the pregnant mouse.

189

Pool, W.F., P.A. Crooks and P.M. Zavos, College of Pharmacy, Graduate Center for Toxicology and College of Agriculture-Animal Sciences Department, University of Kentucky, Lexington, KY--Double label studies with R-(+)-[^3H-N'-CH_3; ^{14}C-N-CH_3]-N-methylnicotinium acetate in vivo in the guinea pig.

R-(+)-[^{14}C-N-CH_3]-N-methylnicotinium acetate (NMN) selectively binds to the male reproductive organs of the guinea pig after peripheral administration. In order to determine whether NMN might be acting as a methylating agent, double labeled NMN was synthesized bearing a C^3H_3 label on the pyrrolidino nitrogen and a $^{14}CH_3$ label on the pyridinium nitrogen with a specific activity ratio of 1.87 to 1.0, respectively. After i.p. administration of $H^3/^{14}C$-NMN to a group of male Dunkin Hartley guinea pigs (n=3; 614±28g) and analysis of the reproductive tissues for radiolabel binding after 24h, most of the radiolabel was located in the cauda epididymis and vas deferens. $^3H/^{14}C$ ratios were as follows: vas deferens (2.3), cauda epididymis (3.2), caput epididymis (2.3) and testis (4.4). These values indicate that the mode of deposition of the N-$^{14}CH_3$ group of NMN into the male reproductive tract is not operating via a methylation mechanism. In vitro experiments with NMN and biological nucleophiles indicate that NMN may be binding to tissues via a pseudobase mechanism, involving nucleophile attack at the electron-deficient C-2 position of the pyridinium ring (Supported by TMRI funds).

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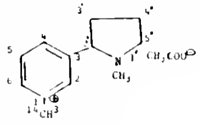
Pool, W.F, P.A. Crooks and P.M. Zavos, College of Pharmacy, Graduate Center for Toxicology and College of Agriculture-Animal Sciences Department, University of Kentucky, Lexington, KY -- Retention of radiolabel in the male reproductive organs of the guinea pig after exposure to a ^{14}C-nicotine metabolite.

The primary nicotine metabolite, N-methylnicotinium acetate (NMN) was synthesized in a radiolabeled form with a $^{14}CH_3$ group attached to the pyridinium N-atom. A group (n=3) of male Dunkin Hartley guinea pigs (625±25g) was treated with R-(+)-[^{14}C-NCH_3]-NMN* (20μCi per animal, i.p.), and housed in metabolic cages in a controlled environment for 24h. The animals were sacrificed via sodium thiamylal overdose injection and tissues were excised and prepared for analysis. The results showed that a high level of tissue retention of radiolabel (0.4% administered dose per g tissue) was associated with the male reproductive tract compared with other tissues. This tightly bound radioactivity was concentrated mainly in the vas deferens (63.5%) and cauda epididymis (25.4%), with smaller amounts detectable in the testis (5.9%) and the caput epididymis (5.3%). Since NMN is a pharmacologically active nicotine metabolite and a potential methylating agent, the demonstration of selective deposition of methyl label in the male reproductive system after exposure to NMN may be of significance in explaining the observed effects of chronic smoking and intensity of smoking (cigarettes/day) on spermatogenesis and seminal characteristics in men (Supported by THRI funds).

*



191

Zavos, P.M., G.W. Gregory and R. Grove, Department of Animal Sciences, University of Kentucky, Lexington, KY--Diurnal distribution of spermatozoa in urine of rams.

Considerable numbers of spermatozoa are voided and lost in the urine in most species. Some researchers have used the pattern of sperm loss in urine to predict the onset of puberty in the male. The objective of this study was to assess the diurnal pattern of sperm loss in urine of rams and identify the time during the 24-hr period at which spermatozoa are mostly found. Six sexually mature rams were used in this study. All animals are confined in crates and urine volume was continuously collected and checked at the following time intervals: 8:00, 12:00, 16:00, 20:00, 24:00; the rams were monitored for 8 consecutive days. Urine volume and sperm count ($x10^6$/ml) were assessed and the total count per time interval and sperm per ml per hour ($x10^6$) were calculated. The sperm count per ml per hour ($x10^6$) for the five corresponding time intervals were: 7.0, 19.1, 37.7, 46.9, and 40.6. Similarly, the urine volume in ml per hour were: 20.3, 49.4, 23.0, 20.0, and 31.4. The correlation coefficient between urine volume and sperm concentration was -0.75. These findings suggest that the level of voided spermatozoa is higher during the pm period (diurnal pattern) and reaches maximum values during the 16:00 to 20:00 time intervals.

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HAYNES, JANICE, CARETHA BRANDYBURG AND JIM ROSS. Benedict College--Effects of Chilling-injury temperature on Chloroplast lipids.

Experiments are being performed to test the ability of liposomes, composed of varying concentrations of thylakoid lipids, to maintain a pH gradient when exposed to chilling-injury temperature (5°C). The lipids being tested are: Monoglactosyldiacylglycerol (MG), digalactosyldiacylglycerol (DG) and phosphatidylglycerol (PG). Liposomes are made with pH 6.6 buffer and neutral red (a pH sensitive dye) trapped inside and pH 9.3 buffer outside. Liposomes composed of DG and DG-PG are able to maintain the pH gradient at 5°C. However, liposomes composed of DG-MG and DG-MG-PG are not able to maintain the pH gradient at 5°C. This data suggests that MC may play a greater role in chilling injury of chloroplast membranes than previously thought.

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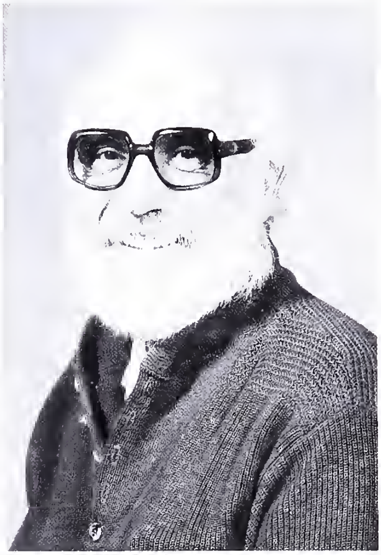
ASB CANDIDATES FOR OFFICE—1988

The Nominating Committee composed of Rudolph Prins, Frank McCormick, and Lafayette Frederick, Chairman, has selected the following slate of nominees for the ASB offices to be filled this year. Additional nominations will be received from the floor. Voting will take place at the Annual Business Meeting April 15 (Friday) 11:45 A.M. Please plan to attend.

President-Elect:	**Edward E. C. Clebsch**, Univ. of Tennessee, Knoxville
	Joe E. Winstead, Western Kentucky Univ., Bowling Green
Vice-President:	**Frank P. Day**, Old Dominion Univ., Norfolk
	Jon R. Fortman, Mississippi Univ. for Women, Columbus
Executive Committee: (Two positions)	**Steve C. Dial**, Pfeiffer College, Misenheimer
	Kenneth W. McLeod, Savannah River Ecology Lab., Aiken
	Jim Ross, Cumberland College, Williamsburg, Kentucky
	Thomas R. Wentworth, North Carolina State Univ., Raleigh

PRESIDENT-ELECT



Edward E. C. Clebsch

Joe E. Winstead

Edward E. C. Clebsch—Dr. Clebsch is Professor of Botany and Ecology at The University of Tennessee, Knoxville since completing his graduate work in botany at Duke University in 1960. His special research interests are in plant ecology. He applies those interests in the Aleutian Islands, in arctic Alaska, and in the Southern Appalachian Mountains. He first attended an ASB meeting in Gainesville, Florida, in 1948. His interest in and service to the organization have been strong since that time. He has served on and chaired the conservation committee and the research awards committee. He served on the executive committee for one term, and was on the local arrangements committee for the last Knoxville meeting. He currently serves on the resolutions committee. He has helped to organize symposia at the annual meetings, has contributed to symposia, and has regularly chaired contributed paper sessions in plant ecology. Among his concerns for ASB beyond the necessary and important routine activities are the following: Should our elections be by mail ballot? Should we re-join AIBS? Do we need a public affairs standing committee? Should we have a printed and distributed directory of members? Should the several organizations which meet with ASB join ASB to form an umbrella organization? The leadership of ASB needs to expand the effort, already under way, toward wider participation of the membership in association affairs.

Joe E. Winstead—Dr. Winstead is Professor of Biology at Western Kentucky University in Bowling Green. A native of Texas, he received his B.S. in Biology (1960) from Midwestern State University in Wichita Falls, Texas. His M.S. work in Plant Ecology was at Ohio University (1962) and after military service (1963–65) he completed the Ph.D. (1968) in Botany at the University of Texas. He joined the faculty at Western Kentucky in 1968 where he has directed the research and thesis work of 16 M.S. students and has had primary teaching areas of undergraduate and graduate ecology courses. He has taught 14 summers as a participant in the Upper Cumberland Biological Station on Center Hill Reservoir in Tennessee. Research efforts and publications in plant ecology have involved both autecological and synecological problems with most recent investigations dealing with sulfur accumulation in wood of various tree species found in deciduous forest systems. Other current studies involve adaptive mechanisms of herbaceous colonizers of strip mined coal spoil banks. He has served as Vice President (1983), President-elect (1984) and President (1985) of the Kentucky Academy of Science. Currently he is a member of the Conservation Committee of the Botanical Society of America and is Chairman of the Endowment Committee of the Southern Appalachian Botanical Club. A member of SABC since 1970 he has served on the Executive Committee, member at large, 1983–86 and has been chairperson of several plant ecology sessions at annual meetings. Other active memberships include Sigma Xi and the Ecological Society of America.

VICE-PRESIDENT

Frank P. Day—Dr. Day is Professor of Biological Sciences and Director of the Ecological Sciences Ph.D. Program at Old Dominion University, Norfolk, Virginia. He received his B.S. degree in Botany (1969) from the University of Tennessee in Knoxville and M.S. (1971) and Ph.D. (1974) degrees in Botany/Ecology from the University of Georgia. Dr. Day's research interests have involved studies of productivity and nutrient cycling dynamics of forested ecosystems, most recently swamps. His current interest is focused on the effects of hydroperiod on below-ground productivity and organic turnover in wetlands. Dr. Day has been an active member of ASB since 1976 and is currently serving on the ASB Student Research Award Committee and as Vice-Chairperson of the South Atlantic Chapter of the Society of Wetlands Scientists. He has served as Vice-Chairperson of the Southeastern Chapter of the Ecological Society of America (1983–85) and as Secretary, Vice-Chairperson, and Chairperson of the Botany Section of the Virginia Academy of Science (1981–84). He is also a member of the Botanical Society of America, the Torrey Botanical Club, the Southern Appalachian Botanical Club, and the American Institute of Biological Sciences.

Jon R. Fortman—Dr. Fortman is Professor of Biology at Mississippi University for Women, Columbus, Mississippi. He received his B.S. degree in Science Education from the University of Florida, M.Ed. from Louisiana State University, M.A. in Biology from Southern Methodist University, and the Ph.D. from Mississippi State University. Fortman's research interests have delt mainly with the genetics and behavior of larval amphibians. Dr. Fortman has been a member of ASB since 1969, and served on the Executive Committee from 1977–79. He is presently serving as News Editor for the *ASB Bulletin* (1973–present). He has been a Regional Director of NABT twice, and is the BSCS Consultant for Mississippi. Dr. Fortman is a former Outstanding Biology Teacher of Florida (NABT), Faculty Member of the Year at MUW (1986), and a STAR faculty member recognized before the Mississippi House and Senate (1987). He holds memberships in the National Association of Biology Teachers, Mississippi Academy of Sciences, Association of Southeastern Biologists, Phi Kappa Phi, and Beta Beta Beta.

EXECUTIVE COMMITTEE

Steve C. Dial—Dr. Dial, Professor of Biology at Pfeiffer College, Misenheimer, North Carolina, is a native of North Carolina. He received his A.B. degree (Biology) from Pfeiffer College; his M.S. (Fish Toxicology) and Ph.D. (Plant Ecology) degrees were taken at the University of South Carolina. He has taught at the Aiken and Lancaster campuses of the University of South Carolina and, since 1963, at Pfeiffer College where he is currently serving as Head of the Department of Biology and Chairman of the Division of Natural and Health Sciences. Dr. Dial is a member of numerous professional organizations including the N.C. Academy of Sciences, S.C. Academy of Sciences, Sigma Xi, and ASB (since 1963). Dr. Dial has served on several state and national committees and was the chairman of the ASB Meritorious Teaching Award Committee in 1985. He presently serves on the Board of Trustees of the ASB Enrichment Fund. His research interests lie in plant ecology (pine tree distribution and ecology) and in invertebrate zoology (freshwater sponge ecology).

Kenneth W. McLeod—Since 1974, following completion of his Ph.D. in Botany and Plant Pathology from Michigan State University, Ken has been with the University of Georgia's Savannah River Ecology Laboratory. He currently is an Associate Research Ecologist and has recently served as Interim Head of the Division of Wetlands Ecology. His formal education also includes B.S. and M.S. degrees from Oklahoma State University. Research interests are focused on radionuclide and elemental cycling in forests, effects of forest management, and physiological responses of tree species to environmental stresses. As a member of ASB since 1974, he has chaired paper sessions at several meetings and currently is chairman of Graduate Student Support Award Committee. He has also contributed to various committees of the Ecological and Southeastern sections of the Botanical Society of America and formerly served as Secretary of the Southeastern Chapter of ESA (1982–84).

Jim Ross—Dr. Ross is Assistant Professor of Biology at Cumberland College, Williamsburg, Kentucky. Jim received his B.S. and M.S. in Biology from Murray State University, Murray, Kentucky and his Ph.D. from the University of Alabama. He was a Junior Researcher at the University of Hawaii from 1981–83, an Assistant Professor of Biology at Benedict College, Columbia, South Carolina from 1983–87 before going to Cumberland College. His teaching duties are in the area of cell biology and his research interersts are concerned with the role of thylakoid lipids in chloroplast function. He has been a member since 1978 and he regularly attends ASB meetings at which he has presented a number of papers. He received the ASB Faculty Research Award in 1984 and has served on the Faculty Research Award Committee (Chairman, 1987). He is also a member of the American Society of Plant Physiologists (and the southern section of the ASPP), the American Society for Photobiology, and the Kentucky Academy of Science.

Thomas R. Wentworth—Dr. Wentworth is Associate Professor of Botany at North Carolina State University. He received the Ph.D. degree in Plant Ecology from Cornell University in 1976, when he joined the Botany Department at NCSU. His research interests include plant-soil interactions, neighborhood models of plant competition, and description, classification, and gradient analysis of vegetation. He has conducted field studies in the mountains of Arizona and North Carolina and is presently conducting research in pine plantations of the North Carolina Piedmont. He has published results of his research in several journals, including *Ecology*, *Journal of Ecology*, *Vegetatio*, and *Soil Science*. His memberships in professional and honor societies include the Ecological Society of America, British Ecological Society, Association of Southeastern Biologists, Torrey Botanical Club, and Phi Beta Kappa. He is currently serving on the Boards of Directors of the Organization for Tropical Studies and the Highlands Biological Station.

EFFECTS OF SEDIMENTATION, GRAZING, AND PREDATION ON SUBTIDAL MACROALGAE OF RADIO ISLAND JETTY, NORTH CAROLINA

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ABSTRACT

The rock jetty on Radio Island, North Carolina, located in the Morehead City/Beaufort Harbor area, has historically been recognized as a location supporting a relatively rich and abundant marine macroalgal assemblage. Previous field studies of algal life histories conducted at the jetty in 1975–76 noted that macroalgae were particularly abundant and diverse on the protected western side of the jetty. Possible effects of competition, grazing, predation, and sedimentation during early stages of subtidal algal assemblage development were investigated during spring and summer by using artificial substrates with asbestos panels oriented vertically and horizontally within complete and partial cages (shade controls). After 12 and 19 wks duplicate sample panels of all treatments were collected and analyzed for percent cover by algae and sessile invertebrates. Sediment accumulated on horizontal surfaces but not on vertical surfaces. Sessile animals dominated space (barnacles and bivalves on vertical surfaces, and polychaetes on horizontal surfaces) within complete cages which excluded grazers and predators. Outside of grazer/predator exclusion cages, a turf of filamentous algae dominated space on horizontal surfaces; barnacles and other animals dominated space on vertical surfaces. Leafy algae, as a group, occupied more space outside of complete cages and were not significantly affected by sedimentation. It appeared that Radio Island jetty, particularly the western side, supported an abundant macroalgal assemblage because of a combination of physical and biological factors. Sedimentation appeared to limit potential sessile invertebrate dominants on surfaces where sediment accumulated, and predation limited the extent of space domination by polychaetes on sediment-influenced surfaces. As a result, space was provided for filamentous and leafy algal coverage. Diversity, as species richness, was lowest on enclosed vertical panels where barnacles and bivalves dominated.

INTRODUCTION

Radio Island rock jetty (also known as Shark Shoal jetty) located inside Beaufort Inlet, North Carolina, has historically been recognized as a southeastern United States coastal site that supports a rich and abundant benthic macroalgal flora (Hay 1986; Hoyt 1920; Kapraun 1977; Stephenson and Stephenson 1952). Although the high algal species diversity has been noted by phycologists, no experimental determination of the factors causing the rich intertidal and subtidal flora has been published. Investigations of rocky intertidal (Dayton 1975; Lubchenco 1978) and subtidal communities (Foster 1975; Osman 1977; Paine and Vadas 1969) demonstrated the importance of biological interactions such as competition and grazing in maintaining algal diversity. Karlson (1978) and Sutherland (1974) demonstrated, in the Beaufort Harbor region, that predation affects the structure and development of subtidal communities. Hay (1986) demonstrated, at Radio Island jetty, that algal associations (epiphytism) permitted increased species diversity by reducing grazing pressure on specific preferred algal species. Competition between barnacles and benthic algae on a seawall in Beaufort Harbor was suggested by Earle and Humm (1964), while Williams (1949) suggested that competition between benthic algae and sessile invertebrates was occurring on the exposed Cape

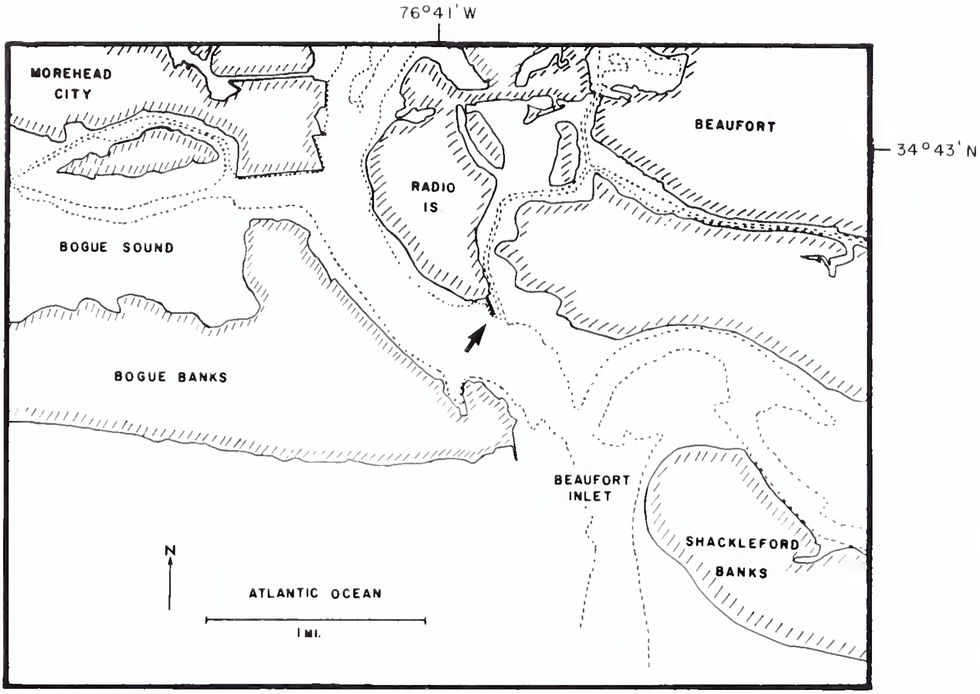

Fig. 1. Location of Radio Island rock jetty study site (arrow) on the western side of the south end of the jetty on Radio Island, North Carolina. Broken lines indicate 4.6 m contour.

Lookout jetty in North Carolina; however, neither study actually demonstrated experimentally that competition or any other biological factor affected the benthic algal abundance.

This study investigated experimentally the effects of predator and grazer exclusion on the early development and structure of a subtidal jetty community in inshore North Carolina, and specifically attempted to determine why Radio Island jetty supports such a rich macroalgal assemblage.

MATERIALS AND METHODS

An area located along the southwestern end of the rock jetty on Radio Island, Carteret County, North Carolina, was used as a study site (Fig. 1). During previous visits and algal life history field research conducted at the jetty, since 1975 (Richardson 1979, 1981, 1982), benthic macroalgal abundance and diversity were higher along the west (protected) side of the jetty. The east side was deeper and faced a channel subject to strong tidal currents. The western side was subject to wave action.

To investigate the possible effects of sedimentation, grazers, and predators on algal community development, artificial substrata were constructed and submerged. Substrata were constructed of 10 × 20 cm asbestos panels wired to cinder blocks which were cemented and wired into a configuration that provided space for eight vertically and eight horizontally oriented panels (Fig. 2). Horizontal panels allowed sediment deposition but vertical panels did not. Three such substrata were constructed. Complete cages of 1.25 × 1.25 cm mesh hardware cloth

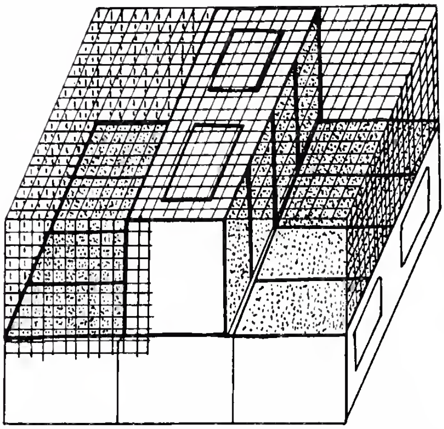

Fig. 2. One artificial substrate of eight completely caged (four horizontal and four vertical) (left side) and eight partially caged (four horizontal and four vertical) (right side) asbestos panels. Sides of cages were wired together at edges and were wired vertically to cinder blocks. No additional supports were needed to keep the cages shaped as illustrated. Cinder blocks were each 40 × 20 × 15 cm. Stippled surfaces indicate asbestos panels, each of which was 10 cm × 20 cm.

were constructed around one-half of each of two substrata. Open cages designed to control for shading and other possible cage artifacts and having two open ends were constructed around the other halves of these two substrata (Fig. 2). The third substrate remained open having no caging material. Thus, the experimental substrata included two complete cages, two partial cages, and two open substrata, with each cage or substratum having four vertical and four horizontal panels. The closed cages could be opened for panel removal. Secure closure was achieved by using surgical tubing and metal fasteners on the one hinged side (large lateral side of cage). Closed cages were designed to exclude grazers and omnivores (purple urchin, *Arbacia punctulata*; spottail pinfish, *Diplodus holbrooki;* pinfish, *Lagodon rhomboides;* sheepshead, *Archosargus probatocephalus*); and predators (black sea bass, *Centropristis striata;* oyster toad, *Opsanus tau;* croaker, *Micropogon undulatus;* spot, *Leiostomus xanthurus;* stone crab, *Menippe* sp.; and blue crab, *Callinectes sapidus*) which occurred at the study site. Shade controls and non-caged substrata permitted these animals access to the panels, and both fishes and urchins were observed inside the shade control cages and on uncaged panels but were not observed inside the closed cages.

The three substrata were submerged to a depth of approximately 1.5 m below mean low water level at the southern end along the western (protected) side of the jetty on 26 April 1977. Light intensity from all directions was measured during low tide on a partly cloudy day with above average underwater visibility with an underwater camera light meter. Based on two years of subtidal observations and collections at the study site, spring (March–May) appeared to be the time of greatest subtidal algal biomass and diversity. Elements of the spring flora, late members of the winter flora, and few early species of the summer flora were all present at this time. The temporal overlap of seasonal algal floras has been noted throughout the Carolinian province by Hoek (1975), Humm (1969), Kapraun and Zechman (1982), Richardson (1987), Searles (1984), and Williams (1948). A yearly spring influx of fishes to the jetty was observed during previous studies (since 1975), and Sutherland and Karlson (1973) also indicated a high degree of invertebrate

Table 1. Species appearing on panels during year. Individual species listed as "other algae" were not analyzed individually.

LEAFY ALGAE

Dasya baillouviana (Gmel.) Mont.
Dictyota dichotoma (Hudson) Lamour.
Calonitophyllum medium (Hoyt) Aregood
Hypnea musciformis (Wulf.) Lamour.
Padina vickersiae Hoyt
Sargassum filipendula C. Ag.

FILAMENTOUS ALGAE

Callithamnion byssoides Arn. in Hook.
Cladophora prolifera (Roth) Kuetz.
Giffordia sp.
Polysiphonia nigrescens (Huds.) Grev.
Polysiphonia tepida Hollenb.

OTHER ALGAE ENCOUNTERED

Leafy

Hypoglossum tenuifolium (Harv.) J. Ag.
Dictyopteris membranacea (Stack.) Batt.

Filamentous

Antithamnion cruciatum (C. Ag.) Naeg.
Bryopsis plumosa (Hudson) C. Ag.
Audouinella sp.
Enteromorpha sp.
Sphacelaria furcigera Kuetz.

ANIMALS

Barnacles
Balanus sp.
Bivalves
Anomia emphippium L.
Crassostrea virginica (Gmelin)
Serpulid Polychaetes

OTHER HARD ANIMALS

Astrangia sp.
Bryozoan sp. 2
Bugula neritina (L.)
Leptogorgia virgulata (LaMarck)
Encrusting Bryozoan
Sponge

SAND-TUBE POLYCHAETES

larval settlement occurred at that time. Spring, therefore, was a time when many potential factors affecting benthic algal abundance, such as potential space competitors, grazers, and predators, were abundant and increasing.

The substrates were visited every 10–14 days to brush clean the cages of fouling organisms. A random numbers table was used to determine the sequence of specific panel removal. One horizontal and one vertical panel each were removed without replacement from each complete cage, partial cage, and from each side of the non-caged substrate of 20 July (12 weeks after submergence) and again on 4 September 1977 (19 weeks after submergence). Thus, two independent replicate samples from each caging and orientation treatment were collected on each date. Additional panel collections were planned for later dates, but no subsequent panel collections were made because the cages were damaged by an autumn storm and complete cages could not be securely closed underwater. Each panel was labeled upon collection, and the panels were transported to the laboratory in a cooler of seawater collected at the jetty. Each panel was examined in the laboratory with the aid of a dissecting microscope at 30× magnification.

A grid of 2.25 × 2.25 cm squares was placed over each panel to aid in the quantification of coverage by each species or type of organism. Coverage in square centimeters of each type of organism was estimated within each 2.25 × 2.25 cm area. Total coverage by each type of organism, on an entire panel, was determined by summing the area covered within each 2.25 × 2.25 cm square for all areas on the panel. The percent coverage of an entire panel, for each type of organism, was calculated by dividing its total actual coverage (in square cm) by the area of each panel (in square cm) and multiplying by 100.

Table 2. Average percent cover of algae on September panels, and summary of 2-way ANOVA tests for effects of orientation (horizontal, vertical) and caging (caged, shaded, none) on percent cover. (H = horizontal, V = vertical panels.)

		Caging			Significance	
Species		Caged	Shaded	None	Orientation	Caging
D. dichotoma	H	1	5	11	ns	$P < 0.001$
	V	0	4	16		
P. vickersiae	H	0	1	1	ns	$P < 0.001$
	V	0	1	1		
S. filipendula	H	2	11	3	ns	ns
	V	0	2	8		
H. musciformis	H	4	3	2	ns	ns
	V	1	1	6		
Tot. leafy algae	H	9	20	16	ns	$P = 0.037$
	V	1	7	30		
P. tepida	H	0	28	91	$0.01 < P < 0.05$	$P = 0.01$
	V	0	0	0		ns
Tot. fil. algae	H	0	28	91	$0.01 < P < 0.05$	$P = 0.01$
	V	1	1	3		ns

To determine the effects of panel orientation, shading, and predator/grazer exclusion on early community development and structure, analyses of variance (one-way and two way ANOVA) of the percent coverage by each type of organism occurring on the panels were performed. Percent cover data were transformed by an arcsine transformation (Sokal and Rohlf 1981) for ANOVA procedures. Duplicate panels of each type of caging treatment and orientation provided two measurements of percent cover for each ANOVA cell. Because some species were rarely or only occasionally present and accounted for very little panel coverage, only species or types of organisms that occurred on three or more panels from each set of panel collections were individually analyzed (Table 1). Species of algae were analyzed separately (Table 2), and in addition, species were lumped into one of two categories, leafy or filamentous algae. Separate ANOVA calculations were performed on each of these two catagories. Animals were also lumped into categories listed in Table 1 for individual ANOVA calculations (Table 3). Percent free space was also analyzed although "free space" on horizontal panels was generally covered by sediment and diatoms.

Effects of caging treatment (complete, partial, and no cage) were indicated as "caging" in Table 3. Effects of complete enclosure versus non-complete enclosure were indicated by "enclosure" in Table 3. For enclosure effect analyses, coverages from panels collected from non-caged and partial-caged substrates were combined as a single treatment and analyzed against completely caged (second treatment) coverages. Effects of shading were determined by ANOVA using coverages on partially caged (one treatment) and non-caged (second treatment) panels. "Orientation," in Table 3, refers to effects resulting from vertical and horizontal orientation of panels and was employed to determine possible effects of sediment deposition on percent cover. Effects of "time" since substrata implantation were analyzed by comparing coverages in July and September.

Table 3. Summary of 2-way ANOVA tests for the effects of caging, enclosure/non-enclosure, shading, orientation, time and interactions on percent cover of taxa developing on panels. (Caging: Caged, Shaded, None; df = 2), (Enclosure: Caged, Shaded + None; df = 1), (Shading: Shaded, None; df = 1), (Orientation: Vertical, Horizontal; df = 1), (Time: July, September; df = 1), (Int. = interaction of the two treatments). Values listed are P-values, and ns (not significant) indicates $P > 0.05$.

	Treatment					
Subject	Caging	Enclosure	Shading	Orientation	Time	Int.
Barnacles, July	ns			0.001		ns
Barnacles, Sept.	0.048			<0.001		0.03
Bivalves, July		0.003		0.02		0.02
Bivalves, Sept.		<0.001		<0.001		0.012
Hard animals, Sept.	ns			<0.001		ns
Fil. algae, horiz.			0.026		ns	ns
Fil. algae, horiz.		0.001			ns	ns
Fil. algae, horiz.	0.001				ns	ns
Leafy algae, Sept.			ns	ns		ns
Leafy algae, Sept.		0.037		ns		ns
D. dichotoma, Sept.		0.003		ns		ns
P. vickersiae, Sept.		0.001		ns		ns
S. filipendula, Sept.		ns		ns		ns
H. musciformis, Sept.		ns		ns		ns
Polychaetes, horiz.		<0.001			0.02	ns
Polychaetes, Sept.		<0.001		<0.001		<0.001
Free space, Sept.	0.007			ns		ns

Cumulative bar graphs representing mean percent cover of each taxon and/or group of taxa from duplicate panels of each treatment were presented in Figures 3 and 4. Means were calculated from the transformed data and then re-transformed for a value of mean percent cover for each taxonomic category.

RESULTS

No differences in light intensity were recorded at the depth of the substrata when the light meter was pointed upward toward the surface or horizontally. Similar incident light intensities from above and from the sides at 1–2 m depths probably resulted from light scattering by the turbid water.

Settlement and development of panel macroalgae was rapid, as noted by Richardson (1979, 1981, 1982) utilizing similar artificial substrata at Radio Island jetty. Of the grazers, omnivores, and predators listed previously, the purple urchin, sheepshead, and black sea bass were observed on or directly over the panels (including within shade control cages) during cleaning of the cages.

Sediment deposition and accumulation was not observed on vertical panels, however sediment accumulation did occur on horizontal panels. Microscopic examination of sediment scraped from free space regions on horizontal panels revealed abundant diatoms living within the accumulated sediment depositions. Richardson (1978) noted a deposition rate at this site of 4 mm during a four week period from 28 August through 25 September 1976, as measured on horizontal panels identical to those used in this study.

Vertically Oriented Panels

Vertical panels were dominated by animals, particularly barnacles, for which caging (predator exclusion) was not significant. Bivalves (*Anomia emphippium*

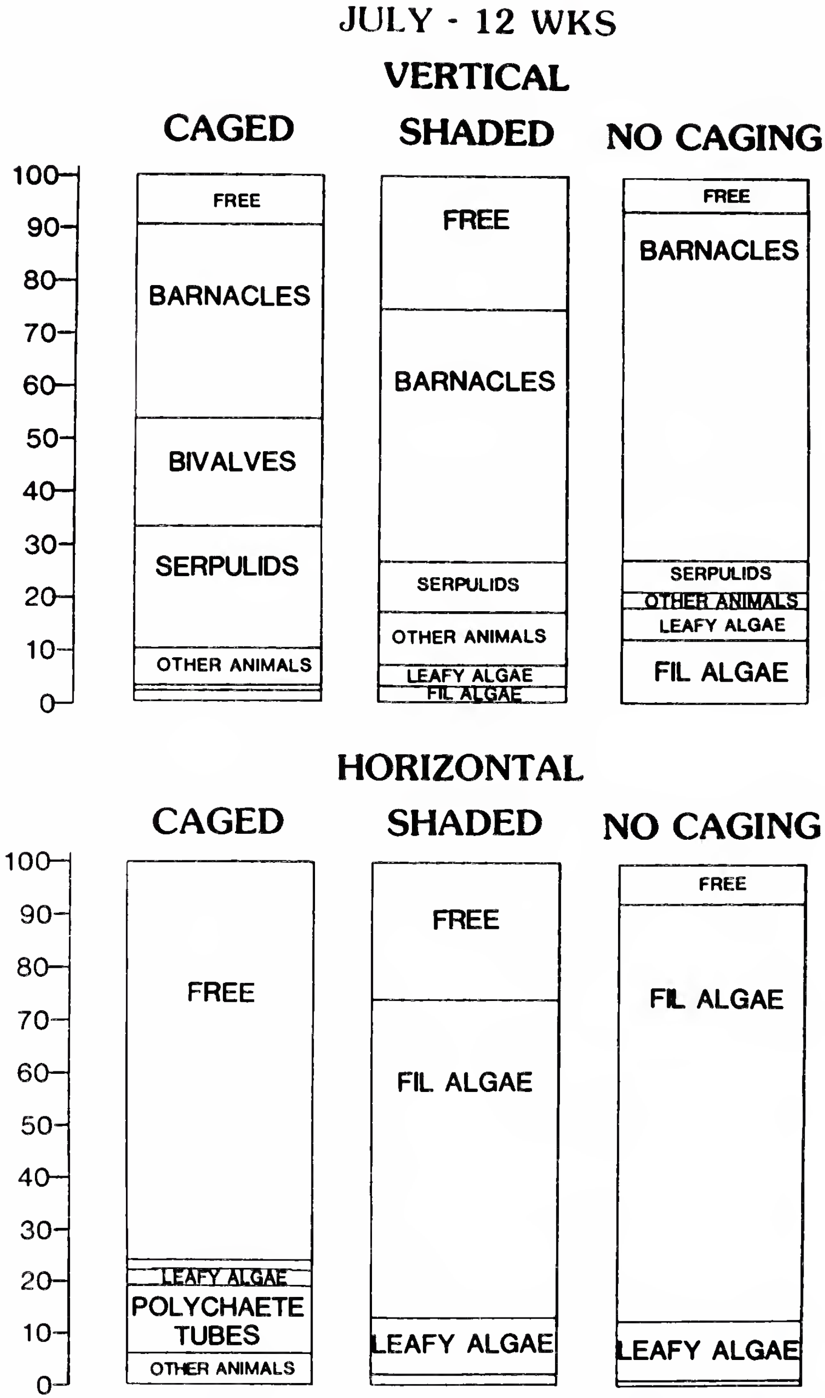

Fig. 3. Cumulative bar graphs representing average percent cover of taxa occurring on July panels. Non-labeled areas represent the following taxa: Vertical Caged: bottom area = filamentous algae; smaller area = leafy algae. Horizontal Caged: filamentous algae; Horizontal Shaded and Non-caged: other animals.

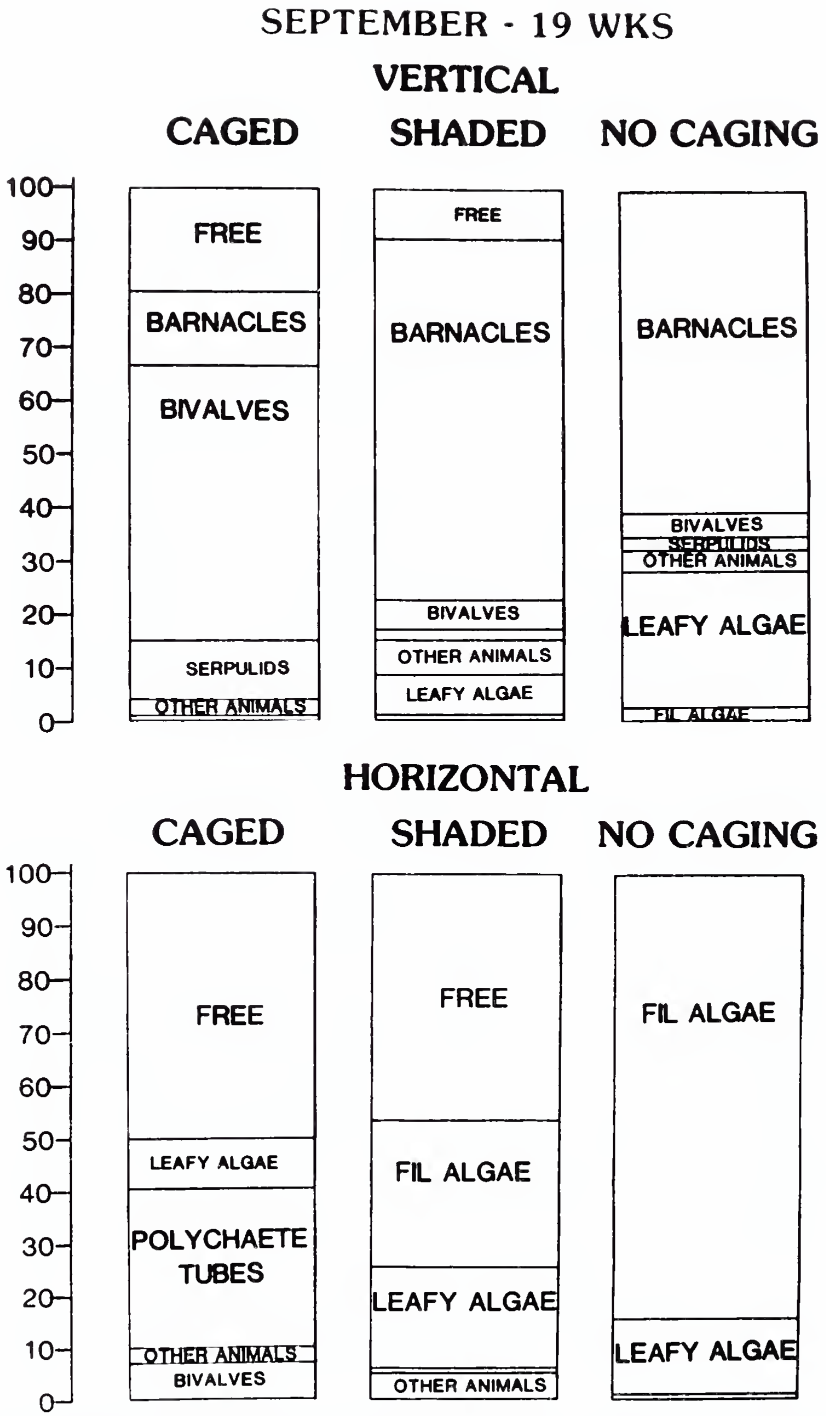

Fig. 4. Cumulative bar graphs representing average percent cover of taxa occurring on September panels. Non-labeled areas represent the following taxa: Vertical Caged: leafy algae; Vertical Shaded: bottom area = filamentous algae; larger area = serpulids. Horizontal Shaded: polychaetes; Horizontal Non-caged: other animals.

and *Crassostrea virginica*) were common only within complete cages (Figs. 3, 4; significance of enclosure: $P = 0.003$, Table 3). Bivalve coverage increased and barnacle coverage decreased from July to September within complete cages. Serpulid polychaetes were common on July panels, but their coverage decreased by September. Filamentous algae were present in small quantities on vertical panels, and leafy algae coverage increased from July to September outside of complete cages (Figs. 3, 4). Shading did not significantly reduce coverage by leafy algae (Table 3).

Horizontally Oriented Panels

Filamentous algae, predominately *Polysiphonia tepida,* dominated space on horizontal panels outside of complete cages (Figs. 3, 4; caging, $P = 0.001$; enclosure, $P = 0.001$, on horizontal panels, Table 3). Sand-tube building polychaetes were common within complete cages. Their coverage increased within complete cages from July to September (Figs. 3, 4; enclosure: $P < 0.001$, Table 3). Although many other animal taxa were present, most were not individually important space occupants on horizontal panels. However, within complete cages, bivalve coverage increased slightly from July to September. Leafy algae coverage also increased through time for all treatments of horizontal panels.

Algae

Orientation was not significant for any species of leafy algae (Table 2). Orientation did affect *P. tepida,* the predominate filamentous alga, as it covered more space on horizontal panels than on vertical panels (Figs. 3, 4; $0.01 < P < 0.05$, Table 2). Coverage by filamentous algae on horizontal panels was significantly greater outside complete cages (enclosure: $P = 0.001$, Table 3). Caging also affected coverage by the leafy algae assemblage as a whole ($P = 0.037$, Table 2), with greater coverage occurring (although species differences were evident) on panels outside complete cages. For the brown algae, *Dictyota dichotoma* and *Padina vickersiae,* caging was significant ($P < 0.001$, Table 2) with more coverage outside complete cages—*i.e.* in the presence of grazers and predators. However for the brown alga, *Sargassum filipendula,* and the red alga, *Hypnea musciformis,* caging was not significant in affecting coverage.

Species Richness

Species richness (number of taxa on each panel) was generally lowest on panels within complete cages (Table 4). Among vertical panels, caging was a significant factor ($P = 0.004$) resulting in fewer species within complete cages. Additionally, among all September panels (horizontal and vertical combined), complete caging resulted in presence of fewer taxa ($P = 0.008$). A two-way ANOVA for September panel species richness indicated an interaction ($P = 0.004$) of orientation and caging with the fewest number of taxa on vertical, completely caged panels.

DISCUSSION

The seasonality effects of some species were noted, *i.e.* species including *Callithamnion byssoides, Giffordia* sp., *Bryopsis plumosa,* and *Dasya baillouviana* settled early on the panels, but because of their seasonal summer decline they

Table 4. Species richness (as number of taxa) on each panel, and significance of orientation and caging on number of taxa appearing on panels, as determined by 2-way ANOVA tests (1–4).

	Caged	Shaded	None
		July	
Vertical	9, 11	9, 11	13, 14
Horizontal	9, 14	11, 11	7, 11
		September	
Vertical	6, 6	9, 12	12, 13
Horizontal	10, 10	12, 11	9, 9

Significant effects:

1) Caging of vertical panels: $P = 0.004$.

2) Caging of September panels (horizontal and vertical panels combined): $P = 0.008$.

3) Interaction of caging and orientation for September panels: $P = 0.004$.

4) All other effects of caging, orientation, and time: ns.

were not important panel space occupants. Richardson has shown that the algae, *D. baillouviana* (1981) and *B. plumosa* (1982), developed only to minute filamentous stages and remained in those reduced forms until the next winter seasonal growing period. Although many macroalgal species were encountered during this study, only those which developed macroscopically in late spring and summer proved quantitatively important as panel space occupants. During field experiments utilizing similar substrates, submerged at the study site every 8–10 wk through 1976 (Richardson 1981, 1982), macroalgae typical of that particular season settled and developed quickly. This caused the panels to appear similar to the jetty rocks, in terms of macroalgal coverage and diversity. Because of this rapid but seasonally different macroalgal community development, and lack of perennial species, except possibly *S. filipendula*, Richardson (1978) concluded that macroalgal succession in coastal North Carolina waters was actually a rapid, seasonal phenomenon, rather than a long-term process.

The west side of Radio Island jetty is subject to rather high sedimentation rates which probably results from its position north of the convergence of two areas of rapid water movement, tidal currents from Morehead City Channel and Bulkhead Channel leading to Beaufort Harbor. The area adjacent to the west side of the jetty functions as a backwater area influenced by multidirectional but lower velocity water movement. Such a protected area of slower moving water would be a region of relatively high sediment deposition since sediment could settle in the quieter water. Based on frequency of dredging and amount of sediment removed, the Corps of Engineers estimated a sedimentation rate of 39 cm/yr in the adjacent docking area west of the jetty. (Kingsbury, H. L., A report on erosion and silting at Radio Island, Morehead City, North Carolina. Unpublished report to the Corps of Engineers, no date.)

Turbid conditions would be expected in an area of multidirectional water movement. Underwater light measurements revealed that incident light intensities from above and the sides were similar at substrate depths. Apparently light scattering by suspended sediment and a light colored natural bottom produced this condition. Light intensities were not measured from within complete and partial cages. Complete and partial cages (shade controls) were designed to permit the same amount of light from above and the largest lateral exposure. Only the two smaller lateral exposures were open on each of the shade control substrates. This design minimized light differences and possible water movement differences within the partial and complete cages. An ANOVA comparing percent cover on shaded and non-shaded panels revealed shading was not significant ($P = 0.240$) for leafy algae on September panels (Table 3). However, comparing leafy algae from completely enclosed with unenclosed panels (Table 3), a more significant effect was indicated by complete enclosure ($P = 0.037$), with more leafy algae being present on unenclosed panels (Figs. 3, 4), where grazing and predation were possible. Specifically, *D. dichotoma* and *P. vickersiae* were most affected by enclosure/non-enclosure as each was more abundant outside of enclosures (Tables 2, 3; $P = 0.003$ and $P = 0.001$ respectively). Among the filamentous algae on horizontal panels, however, shading was possibly a factor affecting abundance. An ANOVA comparing filamentous algal coverage on shaded and uncaged panels (Table 3) revealed less coverage ($P = 0.026$) on shaded panels. Completely enclosed horizontal panels supported a significantly ($P = 0.001$) reduced filamentous algal coverage compared to unenclosed (shaded and non-caged combined) panels (Figs. 3, 4). These results suggested that factors other than degree of shading differences between completely and partially enclosed panels were affecting algal abundances.

The predominant space occupants on vertical panels where sediment did not accumulate were barnacles. Barnacles (Table 3) were much more plentiful on vertical panels than on horizontal panels ($P = 0.001$ for July, $P < 0.001$ for September). Bivalves (Table 3) were also significantly more important space occupants on vertical panels than on horizontal panels ($P = 0.02$ for July, $P < 0.001$ for September). "Hard animals," which included all sessile invertebrates excluding polychaetes, as a whole occupied by September ($P < 0.001$) significantly more space on vertical panels than on horizontal panels. Preferential larval settlement on surfaces less prone to sediment deposition possibly caused this pattern of space occupation by sessile invertebrates. Shorter term examinations of implanted panels would be necessary to determine experimentally whether settlement preferences or survivability after settlement specifically caused the results obtained.

On horizontal panels where sediment did accumulate, sessile invertebrates occupied less space, with the exception of sand-tube building polychaetes on horizontal panels within complete cages (Figs. 3, 4). A two-way ANOVA for September panels (Table 3) revealed that polychaete tube coverage was significantly greater on horizontal panels than on vertical panels ($P < 0.001$) and that coverage within complete cages was significantly greater than outside enclosures ($P < 0.001$). In addition, an interaction of these two factors on polychaete tube coverage was revealed ($P < 0.001$). Neither polychaetes or sand-tubes were observed on exposed surfaces, either on experimental panels or on the jetty itself, except within the complete cages. They were often found attached to the undersides of panels and were seen attached to the undersides of rocks and large shell fragments at Radio Island jetty. On exposed surfaces, worms would be easy prey for fish and crabs. Aquarium observations of fishes readily verified that fishes would consume worms. Thus, in the absence of predators, these worms would be important jetty space occupants on horizontal surfaces.

Direct competition for space between the worms and algae cannot be positively established, based on the results obtained in this study, because of the presence of free space on horizontal caged panels where the worms occurred. Laboratory observations, however, noted that the larger anterior portions of worms moved over the panel surfaces. This activity increased the area impacted by the worms, but this additional area of influence could not be quantified and was not included in the percent cover calculations of occupied area. Thus, the area of worm influence was probably underestimated. Additionally, it was regularly observed that algae were attached to the anterior ends of worm tubes. Species observed attached to tubes included: *D. dichotoma, H. musciformis, Cladophora prolifera,* and the bryozoan *Bugula neritina.* Attachment of drift algae by polychaetes has been noted by Woodin (1974).

Although space competition between polychaetes and algae, in the absence of predators, was not conclusively demonstrated for Radio Island jetty because of the presence of free space, possible competition between polychaetes and filamentous algae on horizontal panels was suggested. Filamentous algal coverage on horizontal panels was greater outside of complete cages than on panels within complete cages (Table 3; $P = 0.001$) on which polychaetes occurred (Figs. 3, 4). *Polysiphonia tepida* grew well on sediment influenced surfaces because its turf-like form permitted horizontal growth by means of prostrate branching filaments (Kapraun 1980). *P. tepida* was apparently grazed, as many erect filaments lacked apical or had regenerated growing tips. Although erect growth was limited, a mode of prostrate growth and spreading allowed *P. tepida* to persist and dominate space, even though grazers were present. This turf growth form also held sediment in place, and thus reduced clean primary settling space by sessile invertebrates. Filamentous algal coverage was less on vertical panels where sediment did not accumulate, compared to horizontal panels (Figs. 3, 4; $0.01 < P < 0.05$, Table 2).

Sedimentation did not appear to limit coverage by leafy algae because coverage differences on horizontal and vertical panels were not significant (Table 2). Shading was also not significant (Table 3). Leafy algal species responded differently to caging. Neither *H. musciformis* nor *S. filipendula* panel coverages were significantly affected by enclosure (Table 3). Both species were present at the jetty year round, and *S. filipendula* appeared as a perennial species. During this and additional studies with similar substrates (Richardson 1981, 1982), *S. filipendula* appeared to be a slower growing species than most of the seasonally occurring algae. Hay (1986) demonstrated that *S. filipendula* was an unpalatable species to grazing fish, and that *H. musciformis* was protected, to a degree, from grazing by growing on or in close proximity to *S. filipendula*. Both *P. vickersiae* and *D. dichotoma* appear as seasonally fast growing species at Radio Island, and their coverage was greater outside complete cages (Tables 2, 3). Hay (1986) determined that *P. vickersiae* was also unpalatable to grazing fishes.

Thus, these leafy algae do not appear to be eliminated at the jetty by grazing or sedimentation. Filamentous algae appear to withstand the degree of sedimentation present, and because polychaetes do not occupy exposed surfaces (because of predation), filamentous algae are not limited by possible competition with polychaetes. As a result, macroalgae can exist on the multitude of surfaces which are either non-preferred or unsuitable for sessile invertebrates. This combination of physical and biological factors contributes to the abundance and diversity of macroalgae on the west side of Radio Island jetty. On enclosed vertical panels, where neither sedimentation nor predation are factors in limiting potential space dominants, species richness is generally low. Such combinations of physical and biological interferences with competitive dominants, and resulting increased community diversity, have been demonstrated in other marine systems (Dayton 1971; Foster 1975; Peckol and Searles 1983; Peterson 1979).

Similar situations might exist at other sites along the southeastern coast where unusually high macroalgal diversities and abundances are found. Recently Richardson (1987) reported such a situation along the Georgia coast where an unusually high number of species exists on the Cumberland Island, Georgia, jetty.

ACKNOWLEDGMENTS

This study represents a portion of a dissertation submitted in partial fulfillment of the requirements for the Ph.D. degree from the Curriculum of Marine Sciences, University of North Carolina. The author thanks all members of his advisory committee, especially Drs. Seth Reice and Charles Peterson, for guidance during this study. I also thank the staff of the Institute of Marine Science, Morehead City, North Carolina, for their logistical assistance during field work. I am indebted to the following for assistance in the field: Jackie Richardson, Willard Bedwell, Dorothy Bedwell, Steve Richardson, Ed Richardson, and Robert Bedwell. The research was supported in part by NSF grant GA42654 to Dr. Max Hommersand, UNC–Chapel Hill. I thank Dr. Patricia Walne for introducing me to the study site and initially generating a desire to conduct field work at Radio Island jetty.

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NEWS OF BIOLOGY IN THE SOUTHEAST

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ABOUT PEOPLE AND PLACES

Alabama

University of North Alabama, Department of Biology. UNA is offering a field trip into the Amazon jungle 14–28 May 1988. This educational program for biology students and biologists is designed to introduce the participants to the tropical rain forest biome of the Peruvian Amazon River Basin. The course includes a several day trip into the Amazon jungle and up to five days at the Institute for Botanical Exploration, a field station in Iquitos, a small city in the upper reaches of the Amazon Basin in eastern Peru. Three semester hours credit for undergraduate and graduate (additional work is required) students is available at the University. Participants are not expected to have any Spanish language skills. The program will be taught by *Dr. Steve Timme,* Assistant Professor of Biology and Associate Research Biologist with the Institute of Botanical Exploration in Iquitos, Peru. He will accompany participants throughout the two week program. The program is limited to 10 persons enrolling for academic or continuing education credit. Advanced registration and payment are required. Call (205) 760-4289 for detailed registration information.

Samford University, Department of Biology. Dr. Anne Cusic joined the Department in September 1987. She teaches genetics, cell biology, and introductory biology courses. She earned her Ph.D. from the University of Alabama at Birmingham and specializes in mammalian teratology. *Dr. Mike Howell,* Head of the Department, is the Professor-in-Residence at the Samford University London Study Centre in England, fall 1987. He is teaching two biology courses at the Centre. *Dr. Ellen W. McLaughlin,* Professor of Biology, was elected President of the University Faculty and Faculty Executive Council for 1987–88.

Florida

Rollins College, Department of Biology. Dr. Persis C. Coleman has been board certified as a genetic counselor by the American Board of Medical Genetics.

Florida State University, Department of Biological Science. Sharon Y. Strauss, Ph.D. student, received the Murray F. Buell Award for Excellence in Ecology from the Ecological Society of America. The award recognizes the best paper presented by a student at the ESA's annual meeting and includes a certificate and $100. Her paper was "Historical Effects of Herbivory on Sumac Fitness." *Robert Reeves,* Associate Professor, was named September Faculty of the Month by Golden Key National Honor Society.

Georgia

Savannah State College, Department of Biology and Life Sciences. Tenure has been awarded to Associate Professors *Dr. Hetty Beard-Jones, Dr. Matthew Gilligan* and *Dr. Joseph Richardson.* A dock for the marine biology program was completed on a tidal creek bordering the campus. Adjacent to it, construction of a marine biology instructional facility has begun. It will house a wet and dry laboratory, classroom, and offices, and is expected to be completed in the spring of 1988.

Valdosta State College, Department of Biology. Dr. Bradley J. Bergstrom (Ph.D. University of Kansas) has been appointed Assistant Professor of Biology. *Dr. Bergstrom* is an ecologist with specializations in mammalogy, animal behavior, and museum curatorship. The Herbarium is pleased to announce the gift of the personal bryological herbarium of *Dr. Robert K. Lampton* (Professor Emeritus of Biology). *Dr. Lampton's* collection of 5,430 moss and lichen specimens is the most extensive documentation of the bryophyte flora of Georgia in existence and is a rich assemblage of taxa from

Wisconsin, Michigan, and several of the New England states. Accession of the collection has been completed and the specimens are now ready for use by researchers. For further information, contact *Dr. Richard Carter,* Curator of the Herbarium, Department of Biology, Valdosta State College, Valdosta, GA 31698.

Agnes Scott College, Department of Biology. Patricia M. White has been appointed visiting Assisting Professor of Biology. *Dr. White* is replacing *Dr. Harry Wistrand* who is serving a term as Associate Dean of the College.

Kentucky

Georgetown College, Department of Biological Sciences. Dr. Tom Seay has been given a one semester sabbatical leave to study the impact of the environment on the history and development of the coal industry in Martin County, Kentucky. *Dr. Charles N. Boehms* has been appointed chairman of the department and will hold the Dwight M. Lindsay Distinguished Professorship. *Dr. Boehms* recently retired from Austin Peay State University as Professor Emeritus.

Western Kentucky University, Department of Biology. Two Assistant Professor positions in Developmental Biology and Molecular Biology are being considered. Applications are invited for two nine-month, tenure-track positions beginning 16 August 1988. Applicants must have completed the Ph.D. and, preferably, have post-doctoral research experience. Applicants for the molecular biology position should have expertise in microbial genetics. Submit curriculum vitae with names, addresses, and telephone numbers of three references and statement of research interests to: Developmental Biologist Search Committee or Molecular Biologist Search Committee, Office of Academic Affairs, Western Kentucky University, Bowling Green, KY 42101. Screening of applicants will begin 15 January 1988.

Louisiana

Louisiana State University, Department of Botany. Dr. Shirley C. Tucker, Boyd Professor of Botany, began her term of office as President of the Botanical Society of America. At the annual meeting of the Phycological Society of America, it was announced that *Dr. Russell L. Chapman,* Professor of Botany, had been elected Vice-President, President-Elect of the PSA.

Mississippi

Gulf Coast Research Laboratory, Ocean Springs. Grants have been received by the Laboratory to study the life history of the Red Drum Population in Mississippi. *Dr. Thomas D. McIlwain,* Assistant Director for Fisheries, and *Dr. Stuart Poss,* Head of the Systematic Zoology Section, are the principal investigators in two separate studies involving Red Drum fish.

North Carolina

Western Carolina University, Department of Biology. The Mountain Aquaculture Center has been established with *Dr. Jerry L. West,* appointed as Acting Director. The Center will organize, direct, and coordinate the following areas of trout biology/aquaculture: research, education, and economic development. *Dr. F. W. Harrison* was elected as the 1989 President-Elect for the American Microscopical Society and has been appointed to serve on the Council on Undergraduate Research.

University of North Carolina at Wilmington, Department of Biological Sciences. Dr. David G. Lindquist, Professor of Biology, has been awarded a Senior Research Fulbright Fellowship to Austria for the summer of 1988.

South Carolina

Erskine College, Department of Biology. Dr. T. Dave Gowan (Ph.D. University of Florida) has joined the Biology Department as Assistant Professor of Cell and Genetics. *Dr. Gowan* completed a post-doctoral year in molecular biology of insect viruses at the Institute of Food and Agricultural Sciences at Florida, and taught for a year at Lock Haven University of Pennsylvania.

University of Georgia, Savannah River Ecology Laboratory. Dr. Phillip Dixon recently joined the SREL staff to fill the position of biostatistician; he was formerly a post-doctoral Research Associate at Cornell University. *Dr. John E. Pinder, III,* has published a book titled *Environmental Research on Actinide Elements*, which was released in October 1987. His co-editors are *James J. Alberts, Kenneth W. McLeod* and *R. Gene Schreckhise.*

Wofford College, Department of Biology. Dr. E. Gibbes Patton, Associate Professor of Biology, has retired. *Dr. Patton* came to the College in 1963. *Dr. Mark D. Norris* (Ph.D. Duke University) is a new faculty member, coming to Wofford from Southern Seminary Junior College, Virginia. *Dr. Norris'* area of expertise is in botany. *Dr. George W. Shiflet* (Ph.D. Vanderbilt University, Molecular Biology and Genetics) has also joined the faculty as Professor of Biology. *Dr. Shiflet* came from Erskine College where he had served as Chairman of the Department of Biology. *Dr. W. Ray Leonard,* chairman of the department, recently received the college's highest faculty honor when he was named the William R. Kenan, Jr. Professor. He earned his Ph.D. at Vanderbilt University.

Tennessee

East Tennessee State University, Department of Biological Sciences. Dr. Dan Johnson attended the 9th International Symposium on Odonatology in Madurai, India. He invited the participants to attend the 10th Symposium at ETSU in August 1989. *Diane Nelson* has been invited to be Course Director for an NSF Short Course on "Tropical Marine Ecology" at the Bermuda Biological Station in May 1988. This past summer she taught a course on Coral Reef Biology in Bermuda for 10 ETSU participants and also received support from the College Center of the Finger Lakes, Bahamian Field Station, San Salvador, to develop a set of slides of marine invertebrates for teaching purposes at the station. *Karen Renzaglia,* supported by a Research Development award, has continued her work on "Ultrastructural Studies of Spermatogenesis in the Bryophytes." She has continued to do collaborative ultrastructural work with *Professor Jeff Duckett* at the University of London, *Dr. Ann Rushing* at Auburn University, and *Dr. Brent Mishler* at Duke University.

Virginia

University of Richmond, Department of Biology. Dr. Barbara A. Mittman (Ph.D. University of Virginia) joined the department in September, 1986. She teaches molecular genetics and researches H-4 histones in yeast. *Dr. Mary A. Smith* (Ph.D. Cornell) joined the department in September 1987. She teaches plant physiology and her research is in plant growth and senescence. *Dr. Warwick R. West, Jr.,* will retire in May 1988 after 36 years at the University.

James Madison University, Department of Biology. Dr. Michael Renfroe (Ph.D. Yale University) has joined the department as an Assistant Professor. *Dr. Renfroe* was a post-doctoral research associate in the Department of Soil and Crop Sciences at Texas A&M University. His area of expertise is in plant cell and tissue culture. *Dr. Reid Harris* (Ph.D. Duke University) has also joined the faculty as an Assistant Professor. He was Temporary Assistant Professor, Department of Zoology at Duke University. He is a population biologist with interests in population regulation, community interactions, and ecological genetics of salamanders. *Dr. Bruce Wiggins* (Ph.D. Cornell University) has joined the department as an Assistant Professor. He is a microbial ecologist with interests in biodegradation of pollutant chemicals and the ecological factors affecting the activity and efficacy of genetically engineered organisms introduced into natural environments. *Dr. Grace Wyngaard* (Ph.D. University of Maryland) joined the department as an Assistant Professor. Her former position was Research Assistant Professor in the Department of Biology at George Mason University. She is a limnologist with expertise in evolutionary ecology and an interest in the integration of ecological and genetic approaches to examine evolutionary problems.

ABOUT MUSEUMS AND BOTANICAL GARDENS

Alabama

Anniston Museum of Natural History. On 14 April 1988, at 10:00 am, *Louise Belden,* Research Associate, The Henry Francis duPont Winterthur Museum, will give a talk on "The Festive Tradition." Tickets are $6.00 at the door.

Kentucky

Museum of History and Science, Louisville. When the American Dental Association reviewed outstanding National Children's Dental Health Month displays for 1987, the Kentucky Dental Association had reason to smile. For the second year the February exhibit, prepared in conjunction with the Museum of History and Science, took home a prize: a meritorious award in the 1987 Samuel D. Harris National Children's Dental Health Month Award Program, and a $1,000 check. Science curator *Alan Goldstein* and assistant curator *Ron Yates* have been in the process of putting together, in order, some 150 bones of a humpback whale. *Yates,* experienced in comparative osteology, carefully measured and aligned the bones. But the City's Largest Jigsaw Puzzle, in the Museum's collection since 1900, had a few pieces missing. This whale is an endangered species—where do you find spare parts? The only well-documented articulated humpback whale in the U.S. is in the Milwaukee Public Museum, so the team paid a visit to measure and study the specimen there. A light-weight material was needed to carve and keep the total weight of the skeleton manageable, so Styrofoam was chosen. In all, about 19 vertebrae, six ribs, and 52 other key bones had to be replaced. *Goldstein* and *Yates* carved replacement pieces, positioned them with the bones and sealed, fiberglassed, and painted their sculpture to preserve it. The skeleton, 51 ft long upon completion, will hang in the Museum's atrium by the end of 1987. New staff include: *Edwina Ashley,* Museum special events coordinator, *Chris Brown,* Museum reservationist, *Taci Campbell,* cashier, *Becky Daily,* Kidspace assistant, *Diane Erickson,* graphic artist, *Janet Gebler,* Starlab and assembly program teacher, *Sandy Hill-Binkley,* Museum Kidspace coordinator, *Rhonda Khol,* history curator, and *Prudie Moffett,* volunteer coordinator. *Dr. William M. Sudduth,* Museum president, was elected to a one year term as president of the Association of Science Technology Centers. *Sudduth* will represent 226 science/technology centers and related institutions from 24 countries. ASTC is a non-profit organization of science museums dedicated to furthering the public understanding and appreciation of science and technology.

Louisiana

Lafayette Natural History Museum Planetarium and Nature Station, Lafayette. Why are an owl's ears uneven? What is the difference between noise and music? How does a deaf person use the telephone? What is the most common sound you produce? Answers to these questions can be found while exploring the world through "The Sense of Sound," an exhibit which opens 28 January 1988, and runs to 31 May 1988.

Mississippi

The Crosby Arboretum, Picayune. The pavilion of the Arboretum has received an Honor Award from the Gulf States Region of The American Institute of Architects. It has also received a first place in the 1987 Architectural Awards Program sponsored by the Red Cedar Shingle & Handsplit Shake Bureau. The pavilion was among six first place winners in a field of 131 entries. A public service video for the Arboretum, produced by WLOX-TV, Channel 13 in Biloxi, Mississippi, recently received a Gold Award from the Gulf Coast Advertising Club.

North Carolina

North Carolina State Museum of Natural History, Raleigh. Dr. Rowland M. Shelley, Curator of Invertebrates, has been awarded an NSF grant for systematic research in the milliped family Eurymerodesmidae. *Dr. Frank J. Radovsky,* former Entomology Department chairman at the Bernice Bishop Museum, Honolulu, has been appointed Director of Research and Collections at the Museum.

ENRICHMENT FUND PROPOSAL

The Board of Trustees for the Enrichment Fund met at North Carolina State University on 12 December 1987, to formulate plans to implement the Enrichment Fund Program established by the ASB members at their 1987 Annual Meeting. The Board developed an innovative proposal that will be presented to the members at the upcoming meeting in Biloxi. This proposal involves novel methods not used previously by ASB to procure broad-based support for the society's programs. The plan will not impose an undue burden on the ASB members, and we expect that the members will find the proposal exciting and productive.

As the society embarks on its second 50 years, we are committed to build upon our previous accomplishments in promoting the advancement of the science of biology on the Southeast. Through the Enrichment Fund, the ASB will have greater opportunity to encourage and reward excellence in teaching and research and the exchange of knowledge in the biological sciences. Please plan to participate in the meetings at Biloxi and become involved in this program.

ASB Enrichment Fund
Board of Trustees

William C. Grant, Chairman
Steve C. Dial
James F. Matthews
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Sharon Patton

APPLICATION FOR ASB MEMBERSHIP

Give copies of this to your students, colleagues, and your school librarian.

Fill out blanks and enclose check or money order for one year's dues and mail to Dr. R. L. Beckmann, Dept. of Botany, N.C. State Univ., Raleigh, N.C. 27695-7612. Please include phone number on application.

Name in full ______________________________ Date ________

Title ______________________________ Department ______________

Institution ____

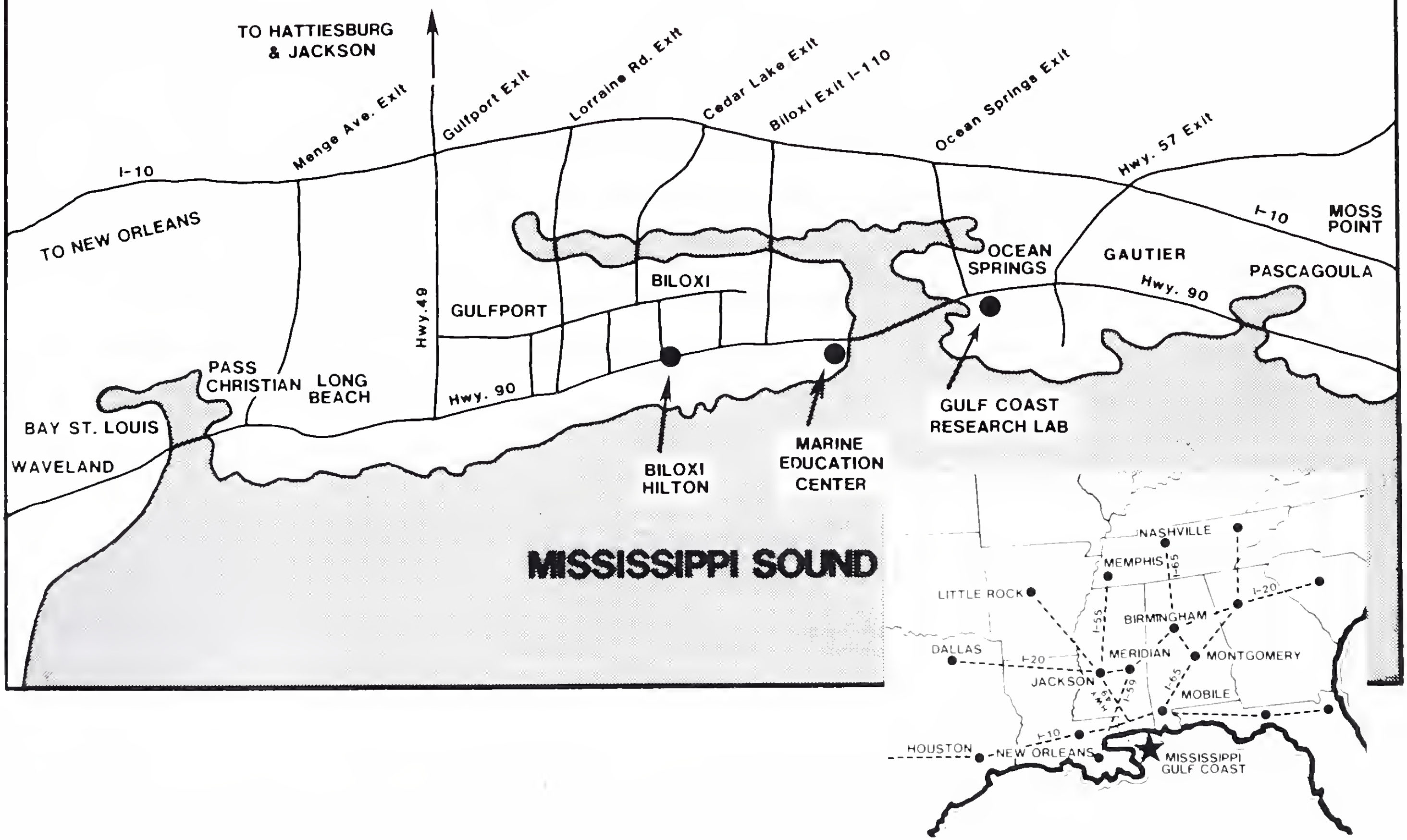
City ______________________________ State __________ Zip ________

Degrees (institutions and dates) ______________________________

Recommended by member ______________________________

Annual Dues:
____ Regular $15.00
____ Contributing $50.00
____ Family $20.00
____ Patron $300.00
____ Graduate Student $8.00
____ Sustaining $100.00
____ Library Subscription $25.00
____ Business Affiliate $100.00
____ Emeritus $10.00

THE MISSISSIPPI GULF COAST



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The ASB BULLETIN

Volume 35, Number 3

July 1988

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A. M. N. H.

The Official Quarterly Publication of
The Association of Southeastern Biologists

ASB Bulletin
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The ASB Bulletin, established in 1954 as the official quarterly publication of the Association of Southeastern Biologists, a non-profit scientific and educational association, is published in January, April, July, and October at Lawrence, Kansas. All contributions should be sent to the Editor. News items should be sent to the News Editor. Inquiries about missing numbers and other circulation matters should be addressed to the Circulation Manager. Subscription orders for institutions should be sent to the Business Manager. Subscription rate for non-members of ASB is $25.00 per year. Printing and typography by Allen Press, Inc., Lawrence, Kansas 66044. Second class postage paid at Philadelphia, PA and additional mailing office.

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1989: Michael Baranski, Department of Biology, Catawba College, Salisbury, NC 28144
Nancy Coile, Curator, University of Georgia Herbarium, Athens, GA 30602
1990: G. W. Gibbons, Savannah River Ecology Lab, Aiken, SC 29802
Diane R. Nelson, East Tennessee State University, Johnson City, TN 37614
1991: Kenneth W. McLeod, Savannah River Ecol. Lab., Drawer E, Aiken, SC 29802
Jim Ross, Dept. Biology, Cumberland College, Williamsburg, KY 40769

The ASB encourages, in the broadest and most liberal sense, the advancement of biology as a science by: the promotion of research, the increase and diffusion of knowledge of biology, emphasis of the relationship of fundamental knowledge of biology to the solution of biological problems, the preservation of biological resources, and by its meetings, reports, discussions, and publications to promote scientific interests and inquiry, thereby adding to the health, happiness, and knowledge of all peoples. The Association meets annually on campuses of universities and colleges located throughout the southeast. Affiliated organizations meeting with the Association are: Southern Appalachian Botanical Club, Southeastern Section of the Botanical Society of America, Southeastern Region of Beta Beta Beta, South Atlantic Chapter of the Society of Wetlands Scientists, Southeastern Chapter of the Ecological Society of America, Southeastern Division of the American Society of Ichthyologists and Herpetologists, Southeastern Fishes Council, and Southeastern Society of Parasitologists. The ASB has representation in Section G Committee of the AAAS. Varying types of membership are available to individuals and institutions. Members receive the Bulletin.

TIME AND PLACE OF FUTURE MEETINGS

1989	April 5–8	University of North Carolina–Charlotte, NC
1990	April 19–21	Towson State University, Towson, MD

PATRON MEMBERS

Carolina Biological Supply Co., Burlington, NC
Martin Microscope Co., Easley, SC

ASSOCIATION AFFAIRS

1988 MERITORIOUS TEACHING AWARD

Dr. Elsie Quarterman

The recipient of the 1988 ASB Meritorious Teaching Award was *Dr. Elsie Quarterman,* Professor Emerita, Vanderbilt University. This award, which consists of a certificate and a check for $1,000 generously provided by the Carolina Biological Supply Company, represents the highest honor the Association of Southeastern Biologists membership can bestow upon one of its members. The significance of this award lies not in the certificate nor in the check but in that its recipient must be nominated and supported by former students and peers. It is a testimony by students and colleagues to good teaching, academic integrity, patience, friendship, and a lot of hard work. *Dr. Quarterman* is a native of Valdosta, Georgia where she received her B.A. degree in English from Valdosta State College. Her M.A. and Ph.D. degrees in Botany were conferred by Duke University. After teaching 11 yr in the Public School System of Georgia, *Dr. Quarterman* joined the Vanderbilt faculty in 1943 and remained there having emeritus status bestowed upon her in 1976. Following her interests in plant ecology and geography *Dr. Quarterman* taught courses in these areas as well as environmental studies, plant anatomy, and septematic botany. During her tenure at Vanderbilt, she directed seven Ph.D. dissertations and at least six master's students. Four of her master's students have since obtained their Ph.D.'s. There is no way of telling how many graduate committees and undergraduate research projects were directed to successful completion by her capable and caring approach. *Dr. Quarterman* has not only directed classroom and academic programs, she has unselfishly served her profession by actively participating in many learned societies. Notably, she is a Fellow in the AAAS and Tennessee Academy of Science, has served as Treasurer, Vice-President and President of the ASB, Vice-President of the American Bryological Society and President of the Tennessee Environmental Council. She has been recognized in Who's Who of American Women, Dictionary of International Biography, and many other such awards. She has published widely in regional, national, and international publications.

In support of her nomination for the award her former students, undergraduate and graduate, commended her for serving as a role model, making them think, fostering synergistic experiences in learning, being a student-oriented teacher, and most of all caring for them personally as well as professionally. *Dr. Elsie Quarterman* truly depicts the epitome of an outstanding teacher.

1988 RESEARCH AWARDS

The **ASB Faculty Research Award** was presented to Dr. Gary P. Shaffer, Joint Assistant Professor at the Coastal Ecology Institute and Department of Experimental Statistics at Louisiana State University, Baton Rouge. Dr. Shaffer is also the chief statistical consultant for the Southern Regional Research Center of the USDA. Dr. Shaffer obtained his Bachelor's and Master's degrees in aquatic and population biology from the University of California at Santa Barbara and his Ph.D. in mathematical ecology at LSU. His primary fields of interest are ecological data analysis, aquatic plant ecology, and cumulative impact management of wetland ecosystems. Dr. Shaffer has published a number of articles in international journals, and he has received several previous awards for his research and conference presentations, including the Eugene P. Odum Award at the 1986 ASB meeting. His award-winning paper for the 1988 ASB Faculty Research Award was entitled, "K-systems analysis for determining the factors influencing benthic microfloral productivity in a Louisiana estuary, USA," and the abstract, in ASB Bulletin Vol. 35, No. 2 was:

> About 3,000 sediment cores from Barataria Estuary, Louisiana were incubated between 26 July and 25 August 1983. For the month, benthic microfloral production measured at a subtidal site consisting of muddy sand was almost twice that measured at a sandy intertidal site (27 g $C \cdot m^{-2}$ compared to 14 g $C \cdot m^{-2}$). However, maximum productivity rates (230 mg $C \cdot m^{-2} \cdot h^{-1}$) were greatest at the sandy site; these rates occurred under periods of subaerial exposure which were limited to late afternoons on 11 days of the study, yet accounted for 43% of the total monthly production at the sand site. Other variables monitored were chlorophyll a, light intensity, water temperature, salinity, benthic community respiration, productivity of the water column, biological activity (muddy sand site), wave height (sand site), meteorological tides (wind induced water levels), tide height, and initial dissolved oxygen. Multichannel information analysis indicated that the information accounted for in productivity by these variables peaked at slightly less than 7- and 3-day periods for the sand site and weak peaks occurred at about 10- and 3-day periods for the muddy sand site. K-systems analysis indicated that the environmental variables acted in combination to influence productivity, and that the combinations changed through time. Physical processes (meteorologic, astronomic, and anthropogenic) largely controlled productivity at the sand site. Productivity at the muddy sand site was influenced by a combination of physical and biological activities.

No **student award** was presented for lack of submissions.

The *Eugene P. Odum Award,* sponsored by the southeastern chapter of the Ecological Society of America, was presented to C. J. Wilczynski and K. L. Gross (Univ. No. Carolina and Kellogg Biol. Sta. Michigan St. Univ., Abstract 138):

Small scale disturbance is common in old fields and make them spatially heterogeneous. Disturbed patches may serve as foci for recruitment of seedlings thus allowing some species to persist within the community. However, the relative success of each species to persist may be affected by biomass allocation patterns, and by success of seedling recruitment. To assess these effects, biomass allocation patterns, and seedling emergence and survival of *Hieracium aurantiacum* and *H. florentinum* were monitored in undisturbed vegetation and experimentally disturbed patches in a 35 year old field in Michigan. There were differences in allocation patterns of these species. Overall, the emergence of *H. aurantiacum* was higher than that of *H. florentinum.* Seedling emergence of both species was highest in bare soil, lowest in litter, and most variable in the undisturbed vegetation. There were no effects of patch size on seedling emergence. Seedling survival through the winter was low in both species. However, survival of *H. aurantiacum* seedlings was greatest in patches of bare soil and increased with patch size. There were no effects of patch size or type on survival of *H. florentinum* seedlings. Small scale disturbances and seedling recruitment can be considered of limited importance to the persistence of *Hieracium* species within this successional community.

The *North Carolina Botanical Garden Award* was presented to L. Davenport (Samford Univ., Abstract 148) on:

Following extensive field work and examination of herbarium specimens, a treatment of southeastern Lemnaceae has been prepared. Included are two species of *Spirodela* (*S. polyrrhiza, S. punctata*), six species of *Lemna* (*L. perpusilla, L. aequinoctialis, L. obscura, L. minor, L. valdiviana, L. minuscula*), two species of *Wolffia* (*W. brasiliensis, W. columbiana*), and three species of *Wolffiella* (*W. lingulata, W. oblonga, W. gladiata*). The distributions of these species in the southeastern United States, as well as problems with their identification and nomenclature, will be discussed.

Graduate Student Support Awards were presented to 16 applicants to help them with costs associated in attending the annual meeting. The number following each name refers to the abstract number as found in ASB Bulletin Vol. 35, No. 2, 1988.

Dunnigan, M. A., Appalachian St. University, NC (187)
Greenberg, K., University of Tennessee, TN (120)
Harkey, G., Memphis St. University, TN (122)
Hill, D. R., Western Carolina Univ., NC (11)
Kokesh, A. C., Marshall University, WV (40, 53)
Mills, E., University of Alabama, AL (5)
Murrell, Z. E., Duke University, NC (151)
Price, G. W., Appalachian St. University, NC (7)
Pride, T. E., Tennessee Tech. University, TN (8)
Ramesh, M. A., Tennessee Tech. University, TN (9)
Ray, D. L., Western Carolina Univ., NC (10)
Soblo, D., Clemson University, SC (11)
Voss, R., Western Carolina Univ., NC (12)
Walton, J. S., Georgia St. University, GA (13)
Wilczynski, C. J., Univ. North Carolina, NC (14)
Wu, X., University of Tennessee, TN (15)

NOTICE OF RESEARCH AWARDS FOR 1989

ASB *Faculty and Student Research Awards* ($500 each). Rules are as follows: (a) Given for especially meritorious paper presented orally by the author(s) at the annual meeting; in order to qualify for presenting the paper, the author(s) must submit an abstract by the December 1 deadline. Papers submitted for the competition must be received in triplicate and in their entirety by January 1 and must be journal-ready manuscripts worthy of publication. A short biographical sketch of each author must accompany the manuscript at the time of submission. (b) Only ASB members are eligible (this applies to all authors). (c) Papers may be in press but not published prior to the previous annual meeting. (d) Papers are judged by eminent scientists selected by the committee from institutions either within or beyond the southeast. Every effort is made to keep authors of submitted papers, as well as the reviewers, anonymous. Judges will use a standard evaluation form that includes the following criteria: significance of ideas, soundness of hypotheses, originality (creativity), quality of methodology, validity of results, soundness of conclusions, clarity, completeness, organization, and contribution to the field. At the discretion of the Faculty and Student Research Award Committees, the award may be withheld or it may be split in case of a tie. (f) Winners will be announced at the annual banquet. The original copy will be sent to the sponsor, and the title, names and affiliations of all authors, abstract, and biographical information will be published with an announcement in the July ASB Bulletin. Send to (faculty): Dr. James Fralish, Dept. Forestry, Southern Illinois Univ., Carbondale, IL 62901 (618/453-3341); Student: Dr. Ken P. Marion, Dept. Biology, University of Alabama, Birmingham, AL 35294 (205/934-3582).

The Eugene P. Odum Award—$100 and a plaque given by the Southeastern Chapter of the Ecological Society of America, for the best ecological paper presented by a student.

The paper will be evaluated by a panel of judges at the time of presentation on the following points: (a) Significance of Ideas; (b) Creativity; (c) Quality of Methodology; (d) Validity of Results; (e) Clarity of Presentation.

Eligibility Requirements:

(a) Undergraduate and graduate students are eligible;
(b) The student must be the sole or senior author;
(c) The paper must deal with a clearly ecological topic and should be presented in any of the following sessions: Aquatic Ecology, Plant Ecology, or Animal Ecology;
(d) The paper must be presented in a regular contributed session; papers presented in poster sessions or symposia are ineligible;
(e) The student does not have to be a member of SE/ESA;
(f) The title and abstract of the paper must be submitted to the Award Coordinator by 1 February. This can be a copy of the abstract submitted to ASB 1 December. Submit to: Dr. Courtney T. Hackney, Dept. Biology, Univ. North Carolina-Wilmington, Wilmington, NC 28403 (919/791-4330)

The North Carolina Botanical Garden Award—$100 given by NCBG (through the Southeastern Section of the Botanical Society of America and the Southern Appalachian Botanical Club). This is given for an especially meritorious paper presented in the areas of plant systematics, evolution, or conservation. The paper will be evaluated by a panel of judges at the time of presentation, on the following points: (a) significance of ideas, (b) creativity, (c) quality of methodology, (d) validity of results, and (e) clarity of presentation. The actual prize will be presented at the ASB Banquet.

Eligibility Requirements:

(a) All individuals eligible to present a paper at the ASB meetings are eligible for this award.
(b) The paper must deal with the systematics, evolution, species biology (including population biology), or conservation of vascular plants that are native or naturalized to the southeastern United States.
(c) The paper must be presented in a regular Plant Systematics contributed-paper session; papers presented in poster sessions or in symposia are not eligible.
(d) The title and abstract of the paper must be submitted to the Award Coordinator by 1 February 1989. This may be a copy of the abstract submitted to ASB 1 December. Individuals interested in entering a paper for this award should submit the title and abstract to: Dr. George Ramseur, Department of Biology, University of the South, Sewanee, TN 37375.

COMMERCIAL EXHIBITORS 1988

Addison-Wesley Publishing Co., Atlanta, GA 30338
Associated Microscope & Service, Elon College, NC 27244
Carolina Biological Supply, Burlington, NC 27215
Conviron, Asheville, NC 28804
Forestry Suppliers, Inc., Jackson, MS 39204
Haake Buchler Instruments Inc., Saddle Brook, NJ 07662
Martin Microscope Co., Easley, SC 29640
Optimetric Division Wild Leita USA, Houston, TX 77060
Parco Scientific, Vienna, OH 44473
S&I Micronics Inc., Birmingham, AL 35244
Sargent-Welch Scientific Co., Birmingham, AL 35202
Ted Pella, Inc., Redding, CA 96099
Wildlife Supply Co., Saginaw, MI 48602
Worth Publishers, Inc., New York, NY 10003

NECROLOGY

Margaret Y. Menzel, Florida St. University, Gainesville, FL
Herbert Parks Riley, University Kentucky, Lexington, KY

ASB ENRICHMENT FUND

The society approved and established the ASB Enrichment Fund at the business meeting 10 April 1987. Contributions and checks destined for this fund should be sent to Dr. R. Beckmann, Department of Botany, North Carolina State University, Raleigh, NC 27695. The Board of Trustees was charged with overseeing the direction and expenditures of this fund. Members of the Board of Trustees are: Drs. W. C. Grant (Chair), S. C. Dial, J. F. Matthews, G. C. Miller, S. Patton, and R. L. Beckmann (Ex Officio).

OTHER BANQUET ACTIVITIES

The society recognized 14 past presidents that attended the meetings at the annual banquet. Charter members W. Duncan and L. Williams were also recognized.

THE ASSOCIATION OF SOUTHEASTERN BIOLOGISTS
TREASURER'S REPORT
1 January 1987–31 December 1987

I. SAVINGS ACCOUNT			
A. Merrill-Lynch Ready Assets Trust			
Balance January 1, 1987	$ 3,537.42		
Net Transfers to/from Checking	6,000.00		
Interest Earned 1987	110.03		
	9,647.45		
II. CHECKING ACCOUNT			
Balance on Hand, January 1, 1987	1,862.84		
A. Receipts			
Regular Dues/Subscriptions	13,869.00		
Annual Meeting	4,927.83		
Bulletin Page Charges	100.00		
Honorarium Reimbursement (Bot. Soc. America)	250.00		
Mailing List	100.00		
Tennessee Dept. Conservation	4,790.00		
N.C. Botanical Garden	100.00		
Miscellaneous	114.38		
Interest	138.16		
TOTAL RECEIPTS		$24,389.37	
TOTAL RECEIPTS & BEGINNING BALANCE			26,252.21
B. Disbursements			
1. Membership Cultivation			
Printing & Mailing, Call for Papers	111.94		
		$ 111.94	
2. Publication			
ASB Bulletin (Vol. 34), Printing	15,581.14		
Roll Maintenance for Bulletin Mailing	548.03		
		$16,129.17	
3. Office Expenses			
Treasurer	9.03		
Editor	16.88		
Stationery Printing	12.00		
Bank Charges	14.29		
Other Officers	42.01		
		$ 94.21	
4. Travel and Related Expenses			
Student Travel Awards	1,704.00		
Speaker Honorarium	500.00		
N. C. Botanical Garden Award	100.00		
Plaques	194.11		
		$ 2,498.11	
5. Research Awards		$ 1,000.00	
TOTAL			19,833.43
NET TRANSFERS TO/FROM SAVINGS			6,000.00
TOTAL DISBURSEMENTS			25,833.43
BALANCE IN CHECKING December 31, 1987			418.78

SUMMARY	
CASH IN CHECKING	418.78
CASH IN SAVINGS	9,647.45
TOTAL ASSETS	$10,066.23
ENRICHMENT FUND	$ 3,285.00

EDITOR'S REPORT FOR 1987

Volume 34 of the ASB Bulletin for 1987 consisted of 172 pages plus a 21 page supplement, that pertained to the history of the society, for a total of 193 pages. This was 33 pages less than the 226 pages in Volume 33, 1986. The 50th anniversary abstracts and the history supplement to issue 2 accounted for the bulk of the pages published. Only one paper and a note, along with society business announcements, were other aspects of the volume.

ASB OFFICERS, COMMITTEES AND REPRESENTATIVES 1988–89

President—William H. Martin, Natural Areas, Eastern Kentucky University, Richmond, KY 40475 (606/622-1476).

President-Elect—Joe E. Winstead, Biology, Western Kentucky University, Bowling Green, KY 42101 (502/745-3696).

Vice-President—Frank P. Day, Biological Sciences, Old Dominion University, Norfolk, VA 23508 (804/440-3595).

Past-President—Rebecca R. Sharitz, Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29802 (803/725-2472).

Secretary—C. Ross Hinkle, Bionetics Corporation, Kennedy Space Center, FL 32899 (305/853-3281).

Treasurer—Robert L. Beckmann, Botany, North Carolina State University, Raleigh, NC 27695 (919/737-3341).

Executive Committee Members-at-Large—

1989: Michael J. Baranski, Biology, Catawba College, Salisbury, NC 28144 (704/637-4442).
Nancy C. Coile, University of Georgia Herbarium, Athens, GA 30602 (404/542-1823).
1990: J. Whitfield Gibbons, Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29802 (803/725-2472).
Diane R. Nelson, Biological Sciences, East Tennessee State University, Johnson City, TN 37614 (615/929-4329).
1991: Kenneth W. McLeod, Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29802 (803/725-2472).
James Ross, Biology, Cumberland College, Williamsburg, KY 40769 (606/549-2200 x 4383).

Editor, ASB Bulletin—Frank J. Schwartz, Institute of Marine Sciences, University of North Carolina, Morehead City, NC 28557 (919/726-6841).

Editor, News & Notes—Jon R. Fortman, Biology, Mississippi University for Women, Columbus, MS 39701 (601/329-4750).

Archivist—Madeline P. Burbanck, Box 15134, Atlanta, GA 30333 (404/373-1413).

AAAS Representative (Section G)—Jerry C. Ritchie, USDA-ARS Hydrology Laboratory, BARC-W Bldg. 007, Beltsville, MD 20705 (301/344-1717).

Enrichment Fund, Board of Trustees—*Chair:* William C. Grant (1991), Zoology, North Carolina State University, Raleigh, NC 27695-7617 (919/737-2011); Robert L. Beckmann (ex-officio), Botany, North Carolina State University, Raleigh, NC 27695 (919/737-3341); Steve C. Dial (1990), Biology, Pfeiffer College, Misenheimer, NC 28109 (704/463-7343); Sharon Patton (1990), Pathobiology, University of Tennessee, Knoxville, TN 37916 (615/546-9230); Grover C. Miller (1991), Zoology, North Carolina State University, Raleigh, NC 27695 (919/737-2011); James F. Matthews (1991), Biology, University of North Carolina, Charlotte, NC 28223 (704/547-2315).

Auditing Committee—*Chair:* Janice Coffey Swab, Science, St. Mary's College, Raleigh, NC 27611 (919/828-2512); Thomas R. Wentworth, Botany, North Carolina State University, Raleigh, NC 27695 (919/737-2168); Grover C. Miller, Zoology, North Carolina State University, Raleigh, NC 27695 (919/737-2011).

Conservation Committee—*Chair:* Jerome A. Jackson, Biology, Mississippi State University, Mississippi State, MS 37962 (601/325-3120); Mark M. Brinson, Biology, East Carolina University, Greenville, NC 27858 (919/757-6307); Katherine Gregg, Biology, West Virginia Wesleyan College, Buckhannon, WV 26201 (304/473-8000 x 8124).

Education Committee (AD HOC)—*Chair:* Franklin Flint, Biology, Randolph Macon College, Lynchburg, VA 24503 (804/846-7392); W. Dean Cocking, Biology, James Madison University, Harrisonburg, VA 22807 (703/568-6225); David J. Cotter, Biological and Environmental Sciences, Georgia College, Milledgeville, GA 31061 (912/453-4246); Lucrecia Herr, Biology, Spring Valley High School, Columbia, SC 29223 (803/788-3550); Janice Coffee Swab, Science, St. Mary's College, Raleigh, NC 27611 (919/828-2521).

Finance Committee—*Chair:* Robert L. Beckmann, Botany, North Carolina State University, Raleigh, NC 27695 (919/737-3341); William Grant, Zoology, North Carolina State University, Raleigh, NC 27695-7617 (919/737-2011); Rebecca R. Sharitz, Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29802 (803/725-2472); Joe E. Winstead, Biology, Western Kentucky University, Bowling Green, KY 42101 (502/745-3696).

Graduate Student Support Award Committee—*Chair:* Dan R. Varney, Biology, Eastern Kentucky University, Richmond, KY 40475 (606/622-2310); Gerhard W. Kalmus, Biology, East Carolina University, Greenville, NC 27834 (919/757-6204); Donald C. Tarter, Biological Sciences, Marshall University, Huntington, WV 25701 (304/696-2706).

Local Arrangements Committee for 1989—*Chair:* James F. Matthews, Biology, University of North Carolina, Charlotte, NC 28223 (704/547-2315); Program Chair: T. Lawrence Mellichamp, Biology, University of North Carolina, Charlotte, NC 29223 (704/547-4055).

Meritorious Teaching Award Committee—*Chair:* Lafayette Frederick, Botany, Howard University, Washington, DC 20059 (202/635-6929); Stewart A. Ware, Biology, William and Mary College, Williamsburg, VA 23185 (804/253-4458); Dorothy Brock, Biology, North Georgia College, Dahlonega, GA 30597 (404/864-3391 x 219).

Nominating Committee for 1989—*Chair:* Donald J. Shure, Biology, Emory University, Atlanta, GA 30322 (404/329-4209); C. J. Biggers, Biology, Memphis State University, Memphis, TN 38152 (901/454-4468); Cliff R. Huff, U.S. Geological Survey, A-413 Federal Building, Nasvhille, TN 37203 (615/736-5424).

Past-President's Council—*Chair:* Rebecca R. Sharitz, Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29802 (803/725-2472).

Place of Meeting Committee—*Chair:* Edward F. Menhinick, Biology, University of North Carolina, Charlotte, NC 28209 (704/547-2315); Don C. Forester, Biological Sciences, Towson State University, Towson, MD 21204 (301/321-2385); George Murphy, Middle Tennessee State University, Box 60, Murfreesboro, TN 37132 (615/898-2847).

Priorities in Public Affairs—*Chair:* George A. Middendorf, III, Zoology, Howard University, Washington, DC 20059 (202/636-6933); Muriel Poston, Botany, Howard University, Washington, DC 20059 (202/636-6929); G. Ronnie Best, Center for Wetlands, Phelps Laboratory, University of Florida, Gainesville, FL 32611 (904/392-2424).

Publications Committee—*Chair:* Michael J. Baranski, Biology, Catawba College, Salisbury, NC 22144 (704/637-4442); J. Whitfield Gibbons, Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29802 (803/725-2472); James Ross, Biology, Cumberland College, Williamsburg, KY 40769 (606/549-2200 x 4383).

Research Awards Committee—Faculty—*Chair:* James Fralish, Forestry, Southern Illinois University, Carbondale, IL 62901 (618/453-3341); Eloise B. Carter, Biology, Emory University, Atlanta, GA 30322 (404/727-6292); Courtney T. Hackney, Biology, University of North Carolina at Wilmington, Wilmington, NC 28406 (919/395-3759).

Research Awards Committee—Student—*Chair:* Ken R. Marion, Biology, University of Alabama, Birmingham, AL 35294 (205/934-3582); Frank P. Day, Biological Sciences, Old Dominion University, Norfolk, VA 23508 (804/440-3595); George E. Stanton, Biology, Columbus College, Columbus, GA 31993 (404/568-2065).

Resolutions Committee—*Chair:* Rebecca R. Sharitz, Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29802 (803/727-2472); Paul Brown, Reelfoot Wildlife Management Area, Rt. 1 Box 147, Tiptonville, TN 38079 (901/253-7343); B. Allen Dunn, Forestry, Clemson University, Clemson, SC 29634 (803/656-4829).

CONSTITUTION AND BY-LAWS OF THE ASSOCIATION OF SOUTHEASTERN BIOLOGISTS

ARTICLE I. Name

The organization shall be known as the Association of Southeastern Biologists.

ARTICLE II. Objectives

The objectives of the Association shall be to encourage in the broadest and most liberal manner the advancement of Biology as a science by the promotion of research in Biology; by the increase and diffusion of knowledge of Biology; by emphasis on the relation of fundamental knowledge of biology to the solution of biological problems; by the preservation of biological resources; and by meetings, reports, discussions, and publications to promote scientific interests and inquiry, thereby adding to the health, happiness, and knowledge of all peoples.

ARTICLE III. Eligibility and Affiliation

Section 1. Members, in general, shall be residents of the Southeastern States and shall be known as (A) Active Members or (B) Emeritus Members. Business or institution members include (C) Business Affiliates, (D) Patron Members, and (E) Library Members.

Section 2. Any person is eligible for active membership in the Association who is engaged in (A) biological research, (B) the teaching of biological subjects, (C) graduate study in the biological sciences, or (D) work in the various fields of applied biology. Active members include regular members, student members, contributing members, and sustaining members.

Section 3. Any member may be elected as Emeritus Member who has been a member of the Association for ten (10) or more consecutive years and who has retired from professional duties. An Emeritus Member shall have the same rights and privileges as an Active Member.

Section 4. Any organization contributing one hundred (100) dollars or more per annum to the support of the Association shall be known as a Business Affiliate. Any individual or organization contributing three hundred (300) dollars or more per annum to the support of the Association shall be known as a Patron. Patron members who sponsor an ASB award will pay the amount of the award and receive the Patron Membership status free from the Association. Business Affiliates and Patrons will receive the publications and notices of the Association and may send representatives to the annual meetings but shall not have the right to vote.

Section 5. Any organized group which is interested in biology may become an affiliate of the Association of Southeastern Biologists upon recommendation of the Executive Committee and approval of the Association at its annual business meeting. The purpose of affiliation is to promote communication and cooperation among the societies involved, but such affiliation does not confer the privilege of individual membership in the Association of Southeastern Biologists upon members of affiliated societies. The terms of affiliation shall be arranged between the Executive Committee of the Association of Southeastern Biologists and each affiliate society.

ARTICLE IV. Officers

The officers of the Association shall be (A) President, (B) President-Elect, (C) Vice President, (D) Secretary, and (E) Treasurer.

ARTICLE V. Annual Meeting

Section 1. The annual meeting of the Association shall be held in April at such place as may be recommended by the Executive Committee and approved by the membership at an annual business meeting. The date of the meeting shall be determined by the Executive Committee.

Section 2. In case of an emergency, the Executive Committee may change the time and place of the annual meeting or may call a special meeting.

ARTICLE VI. Quorum

Fifty (50) members of the Association shall constitute a quorum for the transaction of business.

ARTICLE VII. Disposition of Property

In the event of the dissolution or termination of the Association, title to and possession of all the property of the Association shall pass forthwith to the American Association for the Advancement of Science, Washington, D.C.

ARTICLE VIII. Incorporation

The Executive Committee, with the approval of the membership in a vote at an annual business meeting, may apply for incorporation of the Association as a non-profit scientific and educational organization without capital stock under the laws of any of the southeastern states within its area.

ARTICLE IX. Amendments

Section 1. This Constitution may be amended at any annual business meeting by a three-fourths majority of those present, provided due notice of said amendment has been sent by the Secretary to each member at least thirty (30) days in advance of the meeting, provided the amendment has been proposed by the Executive Committee or by a committee authorized by the Association at a previous annual meeting, and provided that so long as the Association shall be or remain an organization exempt under Section 501 (c) (3) of the Internal Revenue Code of 1954, as amended, no amendment shall be made to Article II or Article VII of this Constitution without consent having been obtained from the Internal Revenue Service.

Section 2. Amendments to this Constitution shall become effective at the close of the annual meeting at which they are adopted.

BY-LAWS

ARTICLE I. Membership

Section 1. Membership shall be granted any eligible person upon receipt of a written application and dues payment for the current year. The application shall include the signature of one active member in good standing, certifying eligibility.

ARTICLE II. Election of Officers

Section 1. (A) Annually the nominating committee shall prepare a multiple slate of nominees for each office or vacancy to be filled. Members are privileged to recommend to the nominating committee persons for any or all offices.

(B) The slate of the nominating committee shall be presented to the membership on or before Thursday evening of the Annual Meeting, and the election shall be held at the following business session when nominations will be called for from the floor.

(C) The Secretary shall prepare ballots for distribution. These ballots shall be distributed and collected by three tellers appointed by the President. A majority vote will constitute election to office. Where more than one person is to be elected to a position (e.g., members of the Executive Committee), the two or more receiving the highest number of votes shall be declared elected.

(D) The results of the election shall be announced as soon as possible after the tellers have counted the ballots, and the successful candidates shall be presented to the membership. All ballots shall be deposited with the Secretary who shall retain them for one year.

Section 2. (A) A President-Elect shall be elected annually and shall become President at the close of the next annual meeting following election.

(B) A Vice President shall be elected annually. Neither the President nor the Vice President shall be immediately eligible for re-election.

Section 3. (A) A Secretary and (B) a Treasurer shall be elected for a term of three (3) years each, and they shall be eligible for immediate re-election to additional terms. The Secretary and Treasurer shall not be elected to office in the same year except to fill an unexpired term.

Section 4. Should an officer other than that of President or that of President-Elect become vacant during the year, the Executive Committee shall appoint a member to fill that office until the next election.

Section 5. Newly elected officers shall assume the duties of their offices at the close of the annual meeting in which they were elected except the Treasurer who shall assume duties on 1 January of the following year.

ARTICLE III. Duties of Officers

Section 1. The President shall be the directing officer of the Association, shall perform the duties usual to that office, and shall appoint, with the advice of the Executive Committee, regular committees, special committees authorized by the Executive Committee, and a representative to the American Association for the Advancement of Science (AAAS). Also, the President shall appoint such other special committees as may be required and shall notify Emeritus members of their election.

Section 2. The President-Elect shall be responsible for organizing the program for the general session of the annual meeting, and shall be responsible for promoting membership in the Association. In the event of the resignation, death, or incapacity of the President-Elect during his or her term of office, the Executive Committee shall declare the person who received the next highest number of votes for the office to be President-Elect. If this individual is unable to accept, the Executive Committee shall nominate two members for the office, to be voted upon by the membership by mail ballots.

Section 3. The Vice President shall be the public relations officer of the Association. In the absence of the President from any meeting the Vice President shall discharge the duties of the office. In the event of the death or resignation of the President, the Vice President shall become President of the Association.

Section 4. The Secretary shall keep records of the meetings of the Association and of the Executive Committee, conduct the routine business of the Association pertaining to the office, attend to the preparation and distribution of ballots at elections, and report the activities of his office to the Association at the annual meeting. The Secretary of the Association shall be Ex-Officio Associate Editor of The ASB Bulletin. In addition the Secretary shall be authorized to sign appropriate papers in case the Treasurer is incapacitated.

Section 5. The Treasurer shall receive and disburse all funds of the Association, the necessary records of dues and funds expended, shall at all times coordinate the efforts of this office with those of the offices of the Secretary and of the Editor, and shall report annually all receipts and expenditures to the membership. The Treasurer is authorized to reimburse the Secretary for expenses incurred in attending the annual meeting of the Association and interim meetings of the Executive Committee. The Executive Committee may by special action also authorize the Treasurer to reimburse other officers of the Association for all or a portion of expenses incurred in attending meetings of the Executive Committee, not to exceed one per year. The Treasurer of the Association shall be Ex-Officio Business Manager of The ASB Bulletin.

ARTICLE IV. Dues and Fees

Section 1. The annual dues of the Association shall be set by the membership following recommendation by the Executive Committee.

Section 2. The fiscal year of the Association shall be from January 1 to December 31.

Section 3. Any member in arrears in the payment of dues in excess of one (1) year at the close of the Annual Meeting shall be dropped from the membership roster by 1 June of that year.

Section 4. Delinquent members who desire reinstatement to membership shall pay a reinstatement fee of one year's dues in addition to the regular dues for the current fiscal year. If the membership has lapsed over five (5) years, the individual must reapply as a new member.

ARTICLE V. The ASB Bulletin

Section 1. The ASB Bulletin shall be the official publication of the Association, and shall be published quarterly or at such other regular intervals as may be determined by a vote of the membership upon recommendation by the Executive Committee.

Section 2. The Editor of The ASB Bulletin shall be a member of the Association, responsible for the editing and publication of the Bulletin, and shall be elected and appointed by the Executive Committee for a term of three years. The Editor shall be eligible for reappointment for any number of successive three-year terms. Upon the recommendation of the Editor, the Executive Committee may appoint a Circulation Manager for the Bulletin.

Section 3. The ASB Bulletin shall be supplied to all members of the Association without charge beyond the stated annual dues. Organizations may subscribe to The ASB Bulletin at a rate equal to the annual dues for contributing members, but such subscriptions will not carry the privileges of membership in the Association. The Executive Committee, upon the recommendation of the Editor, may establish special prices for back issues or volumes of the Bulletin.

Section 4. Any major change in editorial policy proposed by the Editor shall be subject to the approval of the Editorial Board.

ARTICLE VI. Executive Committee

Section 1. (A) The Executive Committee shall be in charge of the affairs of the Association between the Annual Meetings. (B) This Committee shall be composed of the officers of the Association, the immediate Past President, and six (6) members elected from the membership.

Section 2. The six elected members of the Executive Committee shall serve for terms of three (3) years, two members being elected each year. These members are eligible for reelection to the Executive Committee. Should a vacancy occur among these six members, the Executive Committee shall appoint a member to serve until the next election.

Section 3. The Executive Committee shall select and appoint an archivist who shall be custodian of the permanent records or archives and shall, with the approval of the Executive Committee, make such arrangements as may seem appropriate for the collection, care, and maintenance of such records. The archivist shall serve for a term of three years and shall be eligible for reappointment for any number of successive 3-year terms.

Section 4. The Editor of The ASB Bulletin and the Archivist shall be Ex-Officio Members of the Executive Committee with the power of discussion and the privilege of proposing motions but shall not have the right to vote.

Section 5. The Executive Committee shall serve as an Ex-Officio Editorial Board for the Bulletin and shall be responsible for determining the major editorial policies of the Bulletin in consultation with the Editor.

Section 6. A majority of the Executive Committee shall constitute a quorum, provided all members have been notified of the proposed meeting.

ARTICLE VII. Regular Committees

Section 1. The following regular committees shall be appointed by the President upon the approval of the Executive Committee:

A. Auditing Committee
B. Nominating Committee

C. Faculty Research Awards Committee
D. Student Research Awards Committee
E. Meritorious Teaching Award Committee
F. Travel Award Committee
G. Place of Meeting Committee
H. Local Arrangements and Program Committee
I. Resolutions Committee
J. Conservation Committee
K. Finance Committee
L. Publications Committee

Section 2. The duties of the regular committees shall be as follows:

A. The Auditing Committee shall examine the records of the Treasurer prior to the annual business meeting of the Association and shall report the condition of the accounts to the membership at this meeting.

B. The Nominating Committee shall, with due consideration of suggestions received from the membership, prepare a multiple slate of nominees for each office or vacancy to be filled.

C and D. The Research Awards Committees shall each year select recipients of the Association Research Prizes.

E. The Meritorious Teaching Award Committee shall each year select a member of the Association to receive an award for meritorious teaching.

F. The Travel Award Committee shall make monetary awards to assist graduate students to attend the annual ASB meetings.

G. The Place of Meeting Committee shall recommend to the Executive Committee the place where the annual meeting shall be held.

H. The Local Arrangements and Program Committee shall make arrangements for the annual meeting including receipt and scheduling of scientific papers to be presented.

I. The Resolutions Committee shall formulate and present to the Association through the Executive Committee such resolutions as may be considered worthy of action by the Association.

J. The Conservation Committee shall accumulate facts with reference to environmental problems, shall disseminate such information to the membership at its (the Committee's) discretion, and shall bring new resolutions concerning matters of significance to the attention of the Executive Committee, through the Resolutions Committee, for presentation to the membership.

K. The Finance Committee shall review the finances of the society, prepare budget projections for future years, and recommend actions regarding dues structure and other financial matters to the Executive Committee and the membership. The committee shall consist of: ASB Treasurer (Chair), Past President, President Elect, and a member of the Enrichment Fund Board of Trustees.

L. The Publications Committee shall provide oversight of the society's publications, especially the Bulletin, consider requests for special publication activities, and recommend to the Executive Committee matters for presentation to the membership. It shall consist of: Three members of the ASB Executive Committee Members at Large, and Editor (Ex-Officio).

Section 3. The Executive Committee may from time to time establish special ad hoc committees as needed. The members of all such committees shall be appointed by the President.

ARTICLE VIII. Papers

Section 1. All titles of papers and abstracts submitted for the program shall be in the hands of the Program Committee by the date set by the Editor and announced in the Call for Papers.

Section 2. Each title submitted shall be accompanied by two (2) copies of an abstract following the guidelines in the Call for Papers.

Section 3. Except by special action of the Program Committee the maximum time allowed for the presentation of a paper shall be ten (10) minutes. The presiding officer will enforce this rule.

Section 4. Papers presented before the Association at the annual meeting shall be read only by members or by persons introduced by members.

ARTICLE IX. Association of Southeastern Biologists Enrichment Fund

Section I. The Association of Southeastern Biologists (ASB) shall establish and maintain, pursuant to the terms and conditions outlined below, an Association of Southeastern Biologists Enrichment Fund to support educational activities of the ASB. The Association of Southeastern Biologists Enrichment Fund shall support several types of educational activities including the following:

A. Scholarship awards to graduate and/or undergraduate students;
B. Externships and summer research opportunities for undergraduate and/or graduate students;

C. Research prizes for especially meritorious papers presented at the Annual Meeting by students and by senior scientists;
D. Awards to encourage excellence in graduate research and teaching;
E. Meritorious Teaching Award for an outstanding contribution to biology, especially in service to young people;
F. Travel awards to assist graduate students with expenses at the annual ASB meeting;
G. A biology lecture series;
H. Other educational activities of the ASB.

Section 2. Association of Southeastern Biologists Enrichment Fund shall be managed by a Board of Trustees which shall be responsible for the prudent investment of all endowment funds of the ASB. The Board shall consist of five (5) members appointed by the Executive Committee, and the Treasurer as an ex-officio member. Three (3) of the Board members shall be appointed for a term of four (4) years each and two (2) Board members shall be appointed for a term of three (3) years each. Each year, the board shall elect one of its members to serve as Chairperson. The Chairperson shall be eligible for re-election. Board members shall be eligible for reappointment to one (1) additional term on expiration of their term. The Board of Trustees shall report their actions to the ASB at the Annual Meeting. No board member shall receive compensation from the Fund.

Section 3. The Board of Trustees shall receive and administer, as part of the Association of Southeastern Biologists Enrichment Fund, bequests and any other kind of property that may come to them from any source. The Board shall have the power to buy, sell, exchange, lease, transfer, or otherwise dispose of any property, real or personal, with respect to the Fund. Bequests and gifts received for specific purposes shall be administered in accordance with the wishes of the donors. Those bequests and gifts without specifc designations shall be added to the General Fund of the Association of Southeastern Biologists Enrichment Fund, described in Section 4.

Section 4. Contributions to the Association of Southeastern Biologists Enrichment Fund shall be received in three categories as follows:

A. General Fund—Contributions and annual earned income shall be available each year to meet educational activities and objectives as listed in Section 1.
B. Restricted Funds—These are funds given to meet a specific educational activity and/or objective for a period of one or more years.
C. Endowments—Endowments are established to provide long-term support to meet specific educational objectives and activities with only the annual earnings of each endowment expended to meet the objectives for which each was established.

Named Endowments may be established in honor, or in memory, of a distinguished colleague or family member.

Endowments may be established to meet educational activities and objectives as listed in Section 1 and others approved by the Board of Trustees.

Section 5. Income Allocation—The General Fund, Restricted Funds, and Endowments shall be allocated income based on the average balance of each Fund's participation of the total amount invested for the Association of Southeastern Biologists Enrichment Fund for each fiscal year.

Section 6. Investment Policy—In order to protect the funds contributed and entrusted to the trustees of the Association of Southeastern Biologists Enrichment Fund by donors to meet short and long-range objectives, funds shall be invested in government agency securities offering the highest interest rate at the time of purchase. Since changes in the economy and other factors greatly affect interest rates and earnings on securities, funds shall be invested in securities up to a period of five years unless otherwise approved by the Board of Trustees.

Section 7. An audit of the Association of Southeastern Biologists Enrichment Fund shall be made at the close of each fiscal year by the ASB Auditing Committee. The auditor's report shall be presented to the Association of Southeastern Biologists at each annual meeting.

The present Article IX (Amendments) will be changed to Article X, upon approval of the above new article.

ARTICLE X. Amendments

Section 1. These By-Laws may be amended at any annual **business** meeting of the Association by a two-thirds majority vote of those present.

Section 2. Amendments to these By-Laws shall take effect at the close of the meeting at which they were adopted.

REVIEWS

Kevles, Bettyann. 1986. **Females of the Species: Sex and Survival in the Animal Kingdom.** Harvard University Press, Cambridge, MA. $20.00. 229 p.

This is a fascinating book for the behaviorist, general biologist, or general reader. Ms. Kevles's goal is to describe the role of females in sexual selection. She feels that research in this area in recent years has been "intrinsically so fascinating—and scientifically so important—as to merit its own account." Ms. Kevles shows the rich diversity of female behaviors through hundreds of examples (excluding homo sapiens).

She presents, in the first 10 pages, a historical review of the view of the female in sexual selection, beginning with Darwin who developed the theory of sexual selection. Darwin noted that sexual selection comes about through a struggle between males for access to a female and then female expression of a mating preference. She then describes how these ideas affected and conflicted with scientific thought until the mid 20th century.

The remainder of this book describes the role of the female in courtship, mating, motherhood, and sisterhood. She stresses, in each section, that females participate in the fight for reproductive success as actively as males. The courting section describes the female role in looking for a mate, in choosing, and the following rituals. She discusses, in the mating section, reproductive strategies, timing of reproduction, relationships (monogomous to polygamous), promiscuity, incest avoidance, and forced insemination. The motherhood section describes strategies of care in maintaining a stable population, protecting the mother's and the offspring's interests, and male support. The last section on sisterhood deals with females working together (alloparenting, adoption, kidnapping, and orphans), the need for role reversals (female to male), parthenogenesis, and group behaviors (heirarchies, heirs, and suppression of mating). She concludes by warning the reader not to associate human behaviors with the lives of other animals.

Evolutionary biologist Stephen Gould writes, in the article "*Cardboard Darwinism,*" that Ms. Kevles book is "lively," but describes female sexual selection too heavily in the adaptionist mode. He notes that the adaptionist mode she has chosen to use has been the "primary weapon from evolutionary theory used by sexists to keep women in a subservient place." He feels that Kevles has "chosen the wrong weapon" to fight this view. Citing eight examples, he writes that Kevles seems to feel that an "evolutionist's work is done when she has told a plausible story about adaptation, not (as I (Gould) would maintain) when such a tale can be tested with definite evidence against reasonable alternatives." He feels, however, that her central goal to demolish the fallacy that females are passive acceptors in the Darwinian game is important to "celebrate" and is well documented.

With these thoughts in mind, Kevles does present a fascinating discussion of the role of the *Female of the Species* in sexual selection with detailed descriptions of the rich diversity of behaviors within the animal kingdom.

Gould, Stephen J. 1987. Cardboard Darwinism, p. 26–50. *In* S. J. Gould (ed.), An Urchin in the Storm. W. W. Norton Co., New York.

Elizabeth W. Edmondson, *Institute of Marine Science, University of North Carolina, Morehead City, NC 28557.*

Silvertown, Jonathan W. 1987. **Introduction to Plant Population Ecology.** Second Edition. John Wiley & Sons, Inc., NY. $17.95. 229 p.

Plant population ecology, as the author of this book points out, is a twentieth-century science. Its development in Europe has been more rapid than in North America and much of its advancement is based on the work of applied ecologists who have been concerned with such problems as yield density relationships, competition and equilibrium, factors regulating population size, and allocation of energy between reproduction and growth.

This revision of an earlier edition consists of nine chapters including discussions of life tables, population models, demography, evolutionary ecology, competition, and coexistence. The bibliography is extensive, with 600 literature citations. The number of North American citations is impressive and indicates the current level of research activity in this part of the world in plant population ecology. The author makes extensive use of these research papers and the cited data and observations are skillfully synthesized into the text. Many tables and figures redrawn from the cited references are included throughout the book with the result that it is extremely well illustrated. Captions are easy to follow. Considerable space is devoted to an explanation of the $-3/2$ power law and to its importance in the relationship between plant yield and density. The mathematics used in the discussion of simple population models and in the derivation of the $-3/2$ law is easily within the grasp of an undergraduate student.

This book certainly will help to counterbalance the emphasis on animal populations that is found in most population ecology textbooks in this country and in the general ecology textbooks as well. It will be useful as a textbook in courses in plant population ecology and as a sourcebook for the general ecologist.

RICHARD T. HARTMAN, *Department of Biological Sciences and the Pymatuning Laboratory of Ecology, University of Pittsburgh, Pittsburgh, PA 15260.*

Moss, Steven Thomas (ed.). 1986. **The Biology of Marine Fungi.** Cambridge University Press, Cambridge, MA. $49.50. 382 p.

The Biology of Marine Fungi is a welcome addition for the serious student to the literature on marine fungi. The content is based on invited papers, covering several topics, presented at the August 1985, Fourth International Marine Mycology Symposium held at Portmouth Polytechnic, U.K. Previous to this book, two pioneers, Kohlmeyer and Kohlmeyer (1979) in *Marine Mycology: The Higher Fungi,* presented the most up-to-date discussions of marine fungi inclusive of all the currently accepted species, their taxonomy, and ecology (lignicolus). Their efforts gave impetus to research discussed at the symposium, pursued, and published subsequently. *The Biology of Marine Fungi,* edited by Moss, does not include all currently accepted species nor tries to serve this purpose. It does reveal, however, the advancements made by marine mycologists since 1979.

A wide range of topics are covered. The main emphasis is on advancements in taxonomic (evolution) studies of the marine fungi. Previous researchers used spore morphologies as the primary characters for species determination. Many of the papers, however, discussed more useful techniques in determining more natural fungal groupings. A very important chapter on taxonomy (reviewed by Jones *et al.*) discussed these techniques. They stated that ascospore and ascocarp ontogeny is more important in classification of marine fungi than previously employed classical data. Several other chapters (papers) deal with specific studies utilizing newer techniques when classifying marine fungi. Some of these include exoenzyme patterns, other biochemical and physiological characters, EM, and studies of ascus and ascospore structures. A significant chapter (22) reviews teleomorph-anamorph associations which are useful tools in classification and studies of evolutionary trends.

As more knowledge is being obtained on worldwide distributions (not just lignicolus) of marine fungi, ecological research of their economic impact is becoming increasingly studied. Many chapters (2, 3, 24, 25, 26, 27) address these important research areas. Fungal mycoses is becoming an increasingly important area of study as is pointed out because of their effects on economically important marine organisms. However, as pollution becomes an increasing problem of the marine environment, natural micofloras present on seafood are being destroyed, permitting disease pathogens, such as fungi, to successfully become established on those economically important organisms. Several papers discuss this important problem. Porter gives an over-view of the marine classes of parasitic fungi and the organisms they affect.

Another important topic this book discusses is the effect of marine fungi on wood decay. Such organisms are known to destroy wooden structures (piers and pilings) along the coast and thereby cause a large economic impact in replacement effects. Two chapters (28, 29) treat this area of interest, but it was not considered as deeply as I preferred.

In conclusion, this book is worth purchasing and would be invaluable as it provides current up-to-date literature.

Kohlmeyer, J. and E. Kohlmeyer. 1979. Marine Mycology: The Higher Fungi. Academic Press, New York. 690 p.

RICHARD E. BAIRD, *Institute of Marine Sciences, University of North Carolina, Morehead City, NC 28857.*

Barbour, M. B., J. H. Burk, and W. K. Pitts. 1987. **Terrestrial Plant Ecology.** 2nd ed. The Benjamin/Cummings Publishing Co., Menlo Park, CA 94025. $41.50. 634 p.

The highly successful first (1980) edition of this textbook, for advanced undergraduate courses in plant ecology, contained 19 chapters arranged into four parts. Part I (two chapters) introduced, defined, and gave the historical background for plant ecology. Part II (four chapters) was concerned with population dynamics and species interactions. The six chapters of Part III were largely synecological; included were the topics of community analysis, succession, productivity, and mineral cycles. Part IV (seven chapters) was principally autecological; the complex roles of environmental factors were discussed.

In the second edition, like the first, the authors have found it neither possible nor desirable to completely separate plant synecology from autecology. For example, in the last chapter the five major vegetation types of North America are not only described, but also the edaphic and climatic factors responsible for their occurrence are treated.

The new edition retains the same overall arrangement of subject matter. The addition of one chapter (5, Part II), "Life History Patterns and Resource Allocations" reflects the recent developments in this area. Also, there is a new chapter (15, Part IV), "Photosynthesis" separate from "Light and Temperature."

Throughout this edition, there is the frequent appearance of new topics and additional material. Examples of only a few are: the contributions of Robert Whittaker to plant synecology (Chapter 2), a more detailed treatment of mycorrhizae (Chapter 7), remote sensing (Chapter 10), and acid precipitation (Chapter 20). The number of references has increased to more than 1,300.

A reviewer is expected to say something negative about a book. In this case, it is difficult. Of course, each botanist would prefer to see his or her favorite topic or topics treated in more detail. Thus, I could point out the dearth of information on parasitic plants; the word "haustorium" does not even appear in the index. Also, some would like to see a chapter on "Pollution." However, the book already contains more information than can be "covered" in a single semester.

Dr. Barbour and his colleagues have made available a very attractive, superbly organized, and well-written textbook for courses in plant ecology. I am using it this (spring) semester.

Thomas E. Hemmerly, *Department of Biology, Middle Tennessee State University, Murfreesboro, TN 37132.*

NEWS OF BIOLOGY IN THE SOUTHEAST

Jon R. Fortman—*News Editor*
Division of Science and Mathematics
Mississippi University for Women
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ABOUT PEOPLE AND PLACES

Florida

Archbold Biological Station, Lake Placid. David Wahl of the American Entomological Institute, Gainesville, collected six undescribed species of ichneumonid wasps in March 1988. *Don Manley* from Clemson University, and *Mark Deyrup,* Research Biologist at the Station, described two new species of tiny mutillid wasps. *Photomorphus archboldi* is almost certainly nocturnal, uncommon, and known only from scrub habitats in Florida. *Dasymutilla nickeli* is very uncommon and known only from the Station. More recently, *Dr. Deyrup* collected another species of mutillid wasp new for the Station and Florida. This brings the Station list of mutillids to 35 species; a remarkable number for anywhere in eastern North America. Mutillids are known as velvet ants or "cow killers" for their painful sting. *Dr. Robert L. Curry* will fill the postdoctoral position to work on "Territory quality and habitat use in the Florida scrub jay" with Research Associate *Glen Woolfenden* and *John Fitzpatrick. Jim Cronin* is a new Research Assistant. *Karen Lips* is a new Research Intern working for *Jim Layne.* She is a Zoology major from the University of South Florida. *Nancy Stotz,* an Oregon native, is doing her research internship on scrub jays with *Glen Woolfenden. Jim Wolfe,* Executive Director, attended the International Symposium on Latin American Mammalogy in Cancun, Mexico, where he presented a paper on his small-mammal research in Mexico. *Jim Layne* gave a paper on gopher tortoise research at the June Gopher Tortoise Relocation Symposium in Gainesville. *Dr. Eric S. Menges* (Ph.D. University of Wisconsin) joined the staff as a research biologist in plant ecology. His interests are in the areas of demography and life history of rare plants, the effects of habitat fragmentation on genetic structure and ecological traits, and modelling extinction probability and minimum viable population size. He comes to ABS from the Holcomb Research Institute at Butler University.

Florida State University, Department of Biological Science. Sharon Y. Strauss received the *Murray F. Buell* Award for Excellence in Ecology from the Ecological Society of America. The award recognizes the best paper presented by a student and includes a certificate and $100. Her paper was "Historical effects of herbivory on sumac fitness." *Robert Reeves,* Associate Professor, was named September Faculty of the Month by Golden Key National Honor Society. *Walter Tschinkel,* Professor, was elected as secretary of the Florida Department of Agriculture and Consumer Services, Pesticide Review Council. *Paul Elliott,* Professor, was awarded a Council for Instruction grant for his proposal entitled "AIDS Education." *Ann Lumsden,* Instructional Specialist, was awarded a grant with *M. Driscoll* and *J. Dempsey* for their proposal entitled "Strengthening Instruction in APB 1150L, General Biology." *E. Imre Friedmann,* Professor, was conferred the title of concurrent professor by Nanjing University, People's Republic of China, and will be teaching at the University periodically. *Lawrence G. Abele,* Professor, was elected to the rank of Fellow of the American Association for the Advancement of Science. *Dexter Easton,* University Service Professor, presented a paper on Gompertz kinetics of the Na+ channel to the Mathematical Research Branch at NIH, an invited seminar.

Florida Southern College, Department of Biology. The Tissue Culture Laboratory facility is now completed, and introductory cultures have been set up. This has been made possible by matching funds from the Selby Foundation of Sarasota, Florida.

Rollins College, Biology Department. Eileen Gregory, Associate Professor of Biology, has been awarded a Fulbright-Hays Grant to participate in a summer seminar in India. The focus of the seminar will be the changing role of women in India. *Dr. Gregory* will use the material gathered during this trip to develop a new course on the role of women in the development of India. *Donald H. Mansfield,* Assistant Professor, has been invited to join the Citizen Ambassador Program delegation of American biology educators visiting China in the summer of 1988. The delegation, invited by the China Science and Technology Association, will exchange ideas and experience in biology education between the two countries.

University of Miami, Department of Biology. An International Symposium on Tropical Studies was held at the University of Miami campus on 5–8 June 1988, in celebration of the 25th anniversary of the founding of the Organization for Tropical Studies (OTS). The symposium was titled: "Resource Availability and the Structure and Functioning of Tropical Ecosystems." OTS was established in 1963 on the Coral Gables campus of the University of Miami. The consortium consists of four Costa Rican and 40 North American institutions of higher learning. Southern schools include: LSU, Auburn, Georgia, Florida, Duke, North Carolina, NC State, Maryland, Miami, Missouri, Tulane, Texas A&M, and Washington (St. Louis). The consortium pioneered efforts to advance knowledge of the tropics through a series of graduate level courses offered in the field and the development of field stations to expedite research. The North American office of OTS is located at Duke University. *Peter H. Raven* is President of OTS, and *Donald E. Stone* is the Executive Director. The Symposium was cosponsored by The Association for Tropical Biology, an international society of biologists founded in 1963. ATB currently publishes the journal *BIOTROPICA.*

Georgia

Columbus College, Department of Biology. Edward E. Lyons, Assistant Professor, has met requirements for the Ph.D. at Atlanta University. *William S. Birkhead* (Ph.D. University of Texas) has been promoted to Professor of Biology. *George E. Stanton,* Professor and Chairperson, *William S. Birkhead* and *Glenn D. Stokes,* Associate Professor have been awarded an NSF Young Scholars grant to support a summer "Science Challenge" for high ability high school students.

Louisiana

University of Southwestern Louisiana, Department of Biology. Dr. William D. Reese has accepted a five-year term as editor of the *Bryologist. Dr. Scott E. Belanger* has joined the faculty as Assistant Professor. He received his Ph.D. in Environmental Toxicology from VA Polytechnic Institute and State University, where he also held a post-doctoral position. *Dr. Lewis E. Deaton* has also joined the faculty as an Assistant Professor. He received his Ph.D. from Florida State University after which he held postdoctoral positions at the University of Tennessee in Knoxville, SUNY at Stony Brook, and the Whitney Laboratory of the University of Florida. He was an adjunct Assistant Professor at Iowa State University. *Dr. Deaton*'s field of study is comparative physiology. *Dr. Mark Farmer* of Rutgers University has begun a two-year post-doctoral position working with *Drs. Keith Roberts, Roy Brown* and *Betty Lemmon* studying the plant cytoskeleton. *Dr. Michael S. Zavada* has joined the faculty as an Assistant Professor. He received his Ph.D. from the University of Connecticut in 1982. He has held post-doctoral positions at Indiana University and Ohio State, and an Assistant Professorship at the University of Witwatersrand in Johannesburg, South Africa. *Kittie S. Derstine* has been employed as General Biology Laboratory Coordinator. She received her M.S. from Texas A&M University. *Dr. Joe Niegel* (Ph.D. University of Georgia) has joined the department as Assistant Professor. His area of expertise is Population Genetics. *Dr. Robert Twilley* will return to Belize in June and July to continue his mangrove research in conjunction with the Smithsonian Lab at Carrie Bow Cay, Belize.

Mississippi

Gulf Coast Research Laboratory, Ocean Springs. GCRL has been awarded a contract by the U.S. Army Medical Research and Development Command for a three-year study which will use small fish as models for detecting carcinogens. A 35-year love affair with the sea has resulted in one of the largest donations ever made to the Laboratory. *Mrs. Edith Eilert* of Biloxi and her late husband, *Charles,* have donated an impressive collection of 896 seashells from around the world to the Laboratory's J. L. Scott Marine Education Center. GCRL scientists are making a contribution toward preservation of the Mississippi Gulf Coast's top tourist attraction by conducting a project which will use native plants to control sand beach erosion in Harrison County. *Dr. Lionel N. Eleuterius* is the project director for botanical work, and *Dr. Ervin Otvos,* is the principal investigator for geological work.

The University of Mississippi, Department of Biology. The Department now has a resident aquaculturist/manager at their 508-acre Biological Field Station as well as a maintenance manager. *Mrs. Jane Ratliff* has been appointed Research Development Coordinator. She will identify research funding opportunities for the faculty, assist in preparation of funding applications, and maintain records concerning research activities of the department.

South Carolina

University of Georgia, Savannah River Ecology Laboratory. Dr. Michael H. Smith has co-authored a paper which was selected as the "1988 Wildlife Publication of the Year" by The Wildlife Society. The paper, published in the proceedings of an international symposium, is titled "Demographic and genetic characteristics of white-tailed deer populations subject to dog and still hunting." *Dr. Domy C. Adriano* received two awards from the Soil Science Society of America and the American Society of Agronomy. Both professional societies recognized *Dr. Adriano* with prestigious fellow awards for his work in soils, crops, and environmental quality. The fellow award is the highest recognition that these organizations bestow on their members. *Dr. J. Whitfield Gibbons* has been elected Vice President of the Herpetologists' League, the largest society of professional herpetologists in the world.

University of South Carolina, Department of Biology. The second issue of *Biospheres,* the department's newsletter, will be published during May. Two articles featuring research accomplishments with transgenic animals and gene regulation will be included.

University of South Carolina, Institute of Biological Research. In November, the Commission on Higher Education approved the establishment of the Institute, which consists of four facilities: the Oligonucleotide Synthesis Laboratory, directed by *Dr. Robert Lawther*; the Monoclonal Antibody Laboratory, directed by *Drs. Loren Knapp* and *Roger Sawyer*; the Microinjection Laboratory, directed by *Dr. Michael Dewey*; and the Protein Microanalysis Laboratory, directed by *Dr. James Sodetz. Dr. Frank Berger* is the director of the Institute, which provides sophisticated technical services for the University and other facilities.

Tennessee

The University of Tennessee, Knoxville, Department of Botany. Mud flat ecology study information is sought by *Dr. C. C. Amundsen,* Department of Botany, UT, Knoxville, TN 37996. Literature reviews and contact inquiries reveal few geobiological research efforts in Tennessee Valley reservoir drawdown zones.

East Tennessee State University, Department of Biological Sciences. Fred J. Alsop, III, conducted field work this summer, photographing birds for "Birds of Land Between the Lakes." He was also one of several faculty who led field trips for the Roan Mountain Naturalists' Rally in September. *David Benner* attended the Short Course in Medical and Mammalian Genetics given by John Hopkins University and the Jackson Laboratory in Bar Harbor, Maine. *Denise Pav* has been named the program director of the ETSU Medical College Admission Test Review Program. *Diane Nelson* has been invited to be Course Director for an NSF Short Course on "Tropical Marine Ecology" at the Bermuda Biological Station in May 1988. *Karen Renzaglia* gave a symposium paper at the International Botanical Congress in West Berlin on spermatogenesis in bryophytes.

West Virginia

Fairmont State College, Department of Biology. Dr. Steve Stephenson recently returned from India, where he spent the 1987 field season as a Fulbright Scholar at Himachal Pradesh University, Shimla. The purpose of his visit was to study myxomycete ecology in the forests of the northwestern Himalayas. *Dr. Stephenson* is currently a member of the editorial committee of *Castanea* and President-Elect of the West Virginia Academy of Science.

ABOUT MUSEUMS AND BOTANICAL GARDENS

Georgia

Emory University Museum, Atlanta. The Museum of Art and Archaeology will be the recipient of an unprecedented long-term loan of highly significant Roman marble portrait sculptures from the Museo Nazionale Romano in Rome, one of the largest archaeological museums in the world. The first installation will be inaugurated in July 1988, when the Museum will receive 22 Roman marble portrait busts from Rome, ranging in date from the late first century B.C. to the third century A.D. The portraits will be on display at Emory for eight months. In order to expand on this new emphasis in the study of Roman portraiture, the Museum will host an international scholarly symposium on the importance of archaeological context in the study of Roman portraiture in January of 1989. *Dr. Maxwell L. Anderson,* director of the Emory University Museum and *Dr. Leila Nista,* inspector of archaeology at the Museo Nazionale will write the inaugural installation catalogue. *Dr. Nista* is a specialist in marble sculpture, and has curatorial responsibility for the National Museum's collection of portraits, in addition to other material in the vast collections of the museum. *Anderson,* who assumed his Emory appointment 1 September had been assistant curator of the department of Greek and Roman Art at the Metropolitan Museum of Art. A specialist in Roman art, *Anderson* received his doctorate in classical art from Harvard University, and has taught at the University of Rome, Princeton University and the Metropolitan Museum.

Kentucky

Museum of History and Science, Louisville. The Museum is the topic of special attention in the 1977–87 report published by the Institute of Museum Services. The document, titled "Institute of Museum Services, The Collaborative Spirit: Partners in America, Tenth Anniversary 1977–1987," features progress reports about the different types of museums served by IMS. The Museum's Troost mineral collection project is highlighted. The Museum has received a $100,000 donation from Humana, Inc. The funds will be used to build the IMAX theater and in construction of a new exhibit space. The "big theater" is opening in the Museum this year, a four-story screen, six-channel stereo, five million-dollar building project, fifty-film program. The Museum announced today the receipt of a $200,000 pledge from *Mrs. Amelia Brown Frazier.* The Museum presents local, national, and international displays on a changing basis. Temporary exhibitions allow special interest topics to be studied intensely for a short period of time, usually one to three months. The following displays will be available on the following dates: 16 April–19 June "Treasures of Kentucky: Textures," 2 July–28 August "Nature's Fury," 1 October–27 November "Wheels at Work," developed by Boston Children's Museum which is on national tour. The Museum will present 12 March–29 May, six popular robotic critters for the fourth year—like swallows to Capistrano come the dinosaurs to (pre) historic Main Street. On the average the dinosaurs are the most popular Museum temporary exhibit.

At a recent Museum board meeting, foundation president *Mr. A. Stevens Miles* announced the public opening date of the IMAX theater: 23 July 1988. The unique-process film theater features a four-story screen, six-track stereo system and 232-seat capacity with space for 10 wheelchairs. Over 50 movies are available in IMAX super 70-mm format.

Mississippi

The Crosby Arboretum, Picayune. Osmond Crosby will turn over the Editorship of the *News Journal* to *Ms. Marcia Conery,* a Board member from New Orleans. Marcia, who edited the Audubon Society Newsletter for several years, has taken on her new job with enthusiasm.

Mississippi Museum of Natural History. Museum director *B. E.* "Erksine" *Gandy* has retired after almost 29 years of service. *Elizabeth S. Hartfield* has been named as the new director. She formerly served as the museum's Education Coordinator for the past ten years. *Cathy Carter Shropshire,* Curator of Mammalogy, was elected as President for the recently formed Mississippi Association of Biologists. *Diane Loria* has joined the museum staff on contract from The Nature Conservancy. As Director for the Mississippi Natural Area Registry, she will be working with landowners to protect ecologically significant sites in Mississippi. Former director *Chris Fichtel* accepted a new position as Natural Heritage Coordinator in Vermont. *Will McDearman* has been appointed as Research Section Coordinator. He will also continue his former duties as Curator of Botany.

APPLICATION FOR ASB MEMBERSHIP

Give copies of this to your students, colleagues, and your school librarian.

Fill out blanks and enclose check or money order for one year's dues and mail to Dr. R. L. Beckmann, Dept. of Botany, N.C. State Univ., Raleigh, N.C. 27695-7612. **Please include phone number on application ____________________.**

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The ASB BULLETIN

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The ASB encourages, in the broadest and most liberal sense, the advancement of biology as a science by: the promotion of research, the increase and diffusion of knowledge of biology, emphasis of the relationship of fundamental knowledge of biology to the solution of biological problems, the preservation of biological resources, and by its meetings, reports, discussions, and publications to promote scientific interests and inquiry, thereby adding to the health, happiness, and knowledge of all peoples. The Association meets annually on campuses of universities and colleges located throughout the southeast. Affiliated organizations meeting with the Association are: Southern Appalachian Botanical Club, Southeastern Section of the Botanical Society of America, Southeastern Region of Beta Beta Beta, South Atlantic Chapter of the Society of Wetlands Scientists, Southeastern Chapter of the Ecological Society of America, Southeastern Division of the American Society of Ichthyologists and Herpetologists, Southeastern Fishes Council, and Southeastern Society of Parasitologists. The ASB has representation in Section G Committee of the AAAS. Varying types of membership are available to individuals and institutions. Members receive the Bulletin.

Time and Place of Future Meetings

1989	April 5–8	University of North Carolina–Charlotte, NC
1990	April 19–21	Towson State University, Towson, MD

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PRESIDENT'S CORNER

A VIEW FROM HERE

This issue of the *ASB Bulletin* reports the results of a symposium held on Nags Head Woods Ecological Preserve on 14 November 1987 at Kill Devil Hills, North Carolina. Scientists from North Carolina and Maryland provide 10 papers about this biologically-diverse natural area. Carol Mayes indicates how this ecological assessment will assist The Nature Conservancy (TNC) in the development of stewardship plans and preserve management. Bill Odum and Jim and Henrietta List provide the ecological and historical settings for the preserve. These general papers are followed by specific ones on the biota. In publishing these results, *ASB* fulfills the important role of bringing Nags Head Woods Ecological Preserve to the attention of the scientific community. This research also assists TNC in developing and implementing appropriate management practices for this complex ecosystem.

Natural area protection and preservation merely begins with acquisition. Appropriate stewardship practices are essential because preserved areas are far more dynamic and complex than we think they are. Therefore, responsible and informed management practices and monitoring techniques are realized when there are thorough inventories and research that identify the population, community, and environmental attributes of the preserved system. We can be proud that the Association has contributed to documenting and advancing an understanding of this Preserve. In return, The North Carolina Chapter of The Nature Conservancy has provided the funds necessary for this publication. We greatly appreciate this generous support.

The field work by the researchers, and the results of the symposium have quickly extended beyond *ASB* and TNC. Stimulated by these scientists and their work, the National Park Service is now conducting similar inventories at Cape Hatteras, Cape Lookout, Assateague and other National Seashores.

Plan to visit Nags Head Woods Nature Preserve and take this issue with you as a guide. The barrier island and Nags Head Woods Preserve can be reached from Norfolk, VA, Washington, NC and Hatteras Island, NC.

THE ANNUAL MEETING

If you missed the annual meeting of the *Association of Southeastern Biologists* in Biloxi, Mississippi this past April—too bad! For the very first meeting of *ASB* in Mississippi, the Local Arrangements Committee really rolled out the red carpet! WE had beautiful weather, excellent meeting accommodations, and a delicious seafood festival. Those of us from the "northern" states really enjoyed the "deep

South." This pleasant time of year contrasts sharply with the heat and drought most of the Southeast experienced this summer.

The active nature of the members of *ASB* was illustrated again with the excellent symposia, paper, and poster sessions. All of them were certainly well-attended. You can always tell that sessions have good audiences as late arrivals have to sit in the front rows, stand in the back of the room, or lean against the wall. The excellent plenary address by Wyatt Anderson on genetic engineering prompted a lively question-answer period that could have gone on for some time.

Each *ASB* meeting always has some distinctive features. In addition to being the first Mississippi meeting, the South Central and South Atlantic Chapters of the Society of Wetland Scientists met with us. Their active participation in the meeting is most welcomed and appreciated, and they added to the diversity and strength of our association. The paper sessions, poster session, and symposium all show the substantial contribution by the various affiliate societies to that successful meeting.

The successful effort to strengthen our relationship with these chapters and all of the affiliate societies is a major accomplishment of our immediate Past-President, Rebecca Sharitz. Her well-organized, effective leadership in our 51st year has been essential to the continued success of *ASB* as well as our relationships with the affiliates. I would like to personally thank her for such good leadership on behalf of all of us. *Good job, Becky*!

ASB MEMBERSHIP

Traditionally, *ASB* members have been the men and women of southeastern colleges and universities who have conducted biological research and trained the next generation of biologists. In this decade, the *ASB* membership has had a perceptible change in composition. Just look at the papers presented at the Biloxi and Athens meetings and think of the new members you saw. Many are professional biologists of our national laboratories and agencies, state heritage and regulatory programs, private corporations, and consulting firms. Often, they have ties to *ASB* that go back to graduate school. In other cases, they have heard that this is a healthy, active, regional organization of biologists that allows them to talk and do science as they were trained and to mingle with others who play the same game in a relaxed, hospitable atmosphere. (May we keep it that way!) This "new" biologist is more familiar with the public domain and the very real problems of trying to evaluate impacts, monitor species in the face of development, and gather and analyze the data that agencies throughout the southeast must have to make decisions. As the demand for faculty positions remains steady or in some cases declines, these professionals may comprise a larger proportion of *ASB* membership. Their career routes will also be the avenues of employment for many of our students in the near future. Where are the biologists in the biotechnology fields? Let's ask them to join *ASB*, too.

I have asked Ken McLeod to work on general membership solicitation, so he will probably ask several of you at schools throughout the Southeast to help him. He will also be working closely with Ross Hinkle and others to promote *ASB* among biologists in government and business and ask them to participate in our activities. Let us seek ways to make *ASB* meetings, communication in the *Bulletin*, and future programs an integral part of the professional lives of all Southeastern biologists.

ASB AND EDUCATION IN THE SOUTHEAST

Practically every educational report of the 80's decries the state of education, and science education in particular. "Scientific literacy" in the United States is at a low point to say the least. The communication and knowledge gaps between scientists and non-scientists are wide and deep; those between the biologists and non-biologists may be the greatest. Recent international tests given to high school students in 12 developed countries and the United States, show that our senior students (in an advanced course) ranked *dead last* in biology! We do not have to look far to see limited understanding of basic biology in the general population. Look at the continued negative reactions to the teaching of evolution; consider the public responses to sex education programs; recall the attacks on any hapless endangered species that halts development. Without getting into details here, imagine how students and adults in the Southeast compare with the rest of the country. According to all of these reports, something has to be done. So, when does the handwringing stop and action begin? What can an organization like *ASB* do? If most of us agree there are problems in biological education in our region, how is the collective will of an organization such as our going to have any impact or influence?

Indeed, the membership is interested in education. In the recent survey of memebers interested in serving *ASB,* membership on an Education Committee was second only to conservation. In this past July Bulletin, you see an *ad hoc* Education Committee chaired by Past-President Frank Flint. The charge to this committee is in two parts: 1) Identify the major problems of biological education of young people in the Southeast; 2) identify the role of ASB in improving the situation. In early June, Frank was a gracious host for the committee at Randolph-Mason College for Women in Lynchburg, Virginia. In a long, one-day, intensive session, the Committee made some plans for initial action. They also made plans to present their response to the charge at our Charlotte meeting next April; more about that later. If you expressed an interest in the Education Committee, you may be called upon sooner than you expected.

We have a long way to go in defining *ASB*'s role in education and effectively addressing such a poor understanding of life. However, we should take the first steps. If biologists do not become involved in education, then we leave a niche to be filled. We do know something about empty niches.

ASB AWARDS

The interest in our Research Awards has been low in the past few years. The Student Research Award is generously sponsored by Martin Microscope Company. This year, not one paper was submitted. Surely, *one* student in 13 states has conducted research that *ASB* can recognize.

The Executive Committee has moved to clarify award guidelines and Diane Nelson and Whit Gibbons are coordinating the effort to bring these awards to the attention of the membership. Watch for separate, special announcements in addition to our regular Call for Papers. Please remind colleagues and students of their availability.

ASB ACTIVITIES IN 1988–89

ASB ENRICHMENT FUND: Through the efforts of the Enrichment Fund Board of Trustees and Past-Presidents Donald Shure and Rebecca Sharitz, you are all aware of the Enrichment Fund. Times have changed. Over 50 years, *ASB* has grown in size and complexity and the organization is trying to meet the increased needs and interests of this larger and more diverse membership. Your contribution to the Fund helps *ASB* continue to contribute to the advancement of biology, the training of professional biologists, and the development of programs appropriate for the organization. The Board will be meeting this year to consider support of *ASB* beyond the membership. To attract potential contributors who are non-biologists means that we are going to provide some services for them or their interests. Why should any individual, corporation, private or public agency support us? What can we do best? One possibility is to sponsor well-executed, interesting field trips for the public in the Southeast. Any service such as this one or others identified by the Board will require considerable time and effort to develop and implement with a measurable degree of success. Please be available if the Board calls on you to help them with the *ASB* Enrichment Fund.

CONSERVATION: One of the most active standing committees of *ASB* has always been the Conservation Committee. I have asked this Committee to identify at least one conservation issue in the Southeast to be brought to the attention of the membership for action at the annual meeting. With human demands on lands and waters, the development of wetlands and coastal areas, environmental quality problems, and loss of native plant and animal habitats, there will *always* be conservation matters in the Southeast. Every *ASB* meeting should address *at least one* local, state, or regional issue. If we agree on a particular action or position, we should then take the necessary steps to inform the public and decision-makers of our decision.

ASB BULLETINS: Last year many of you responded to a questionnaire regarding the role of the *ASB Bulletin* and its effectiveness as a journal of the Association. By the time you receive this issue, the Publications Committee will have reported at an interim meeting of the Executive Committee this past September. Their findings and the recommendations of the Editor and the Executive Committee will be reported in the months ahead.

50*th MEETING*

We have recently celebrated the 50th Anniversary of the Association of Southeast Biologists. This April, the 1989 meeting in Charlotte will be the 50*th Meeting* of this strong organization. Plan now to attend, present a paper, visit with old and meet new friends. *See you in Charlotte*!

SYMPOSIUM

ECOLOGY, FLORA, AND FAUNA ASSOCIATED WITH INTERDUNAL PONDS OF NAGS HEAD WOODS ECOLOGICAL PRESERVE, NORTH CAROLINA

14 NOVEMBER 1987

NAGS HEAD WOODS ECOLOGICAL
PRESERVE VISITORS CENTER
KILLS DEVIL HILLS, NC 27948

SPONSORED AND SUPPORTED BY THE
North Carolina Nature Conservancy—
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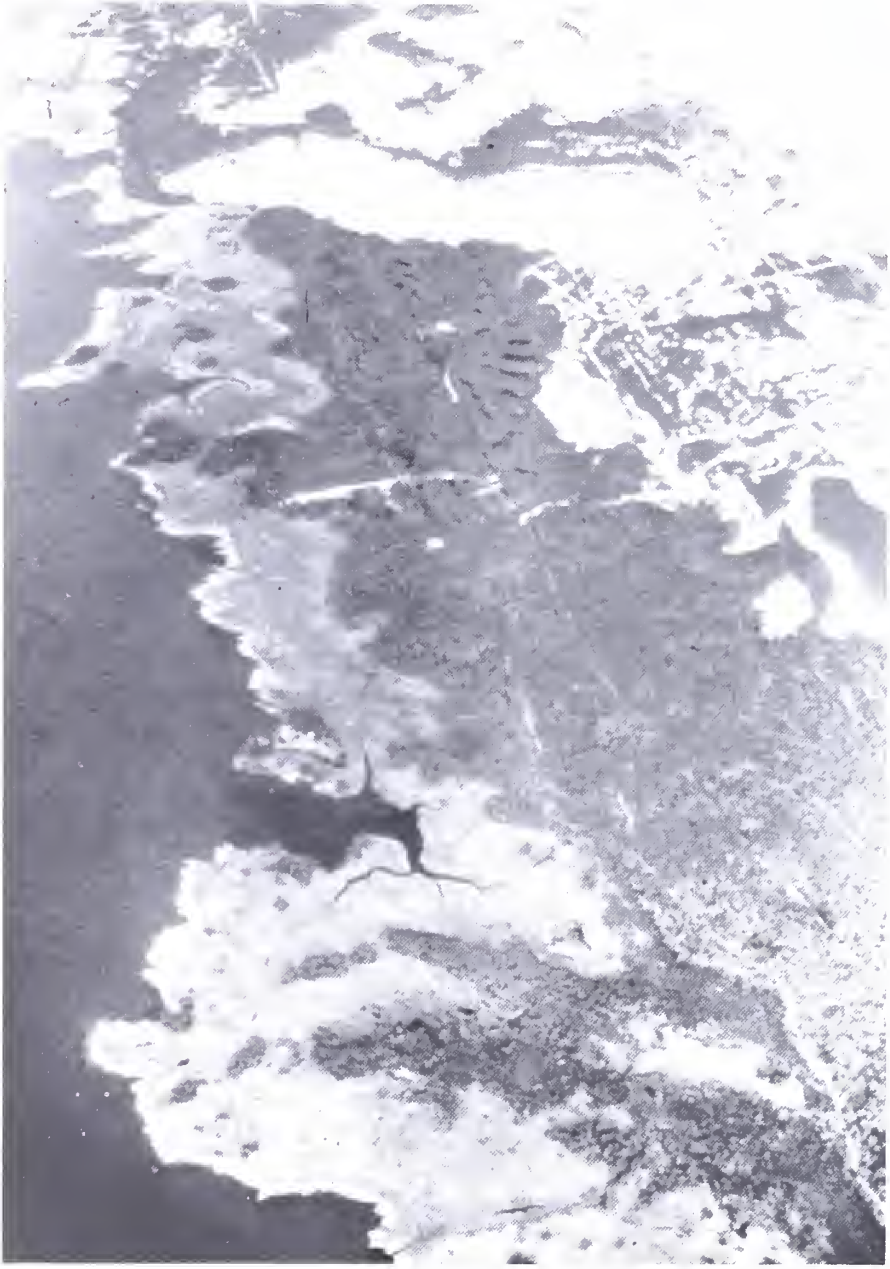

Aerial view looking southwest to northeast from Currituck Sound (on left) across marshes, the Nags Head Woods with its ponds (center dark area), Run Hill sand dune (light area across top of picture) toward the Atlantic Ocean (extreme upper right). Kill Devil Hills is visible on the right. Fresh pond (water reservoir) is elongate body at extreme middle right. Photo courtesy Nature Conservancy, Chapel Hill, NC.

A SYMPOSIUM ON INTERDUNAL PONDS IN MARITIME FORESTS. NAGS HEAD WOODS ECOLOGICAL PRESERVE, NORTH CAROLINA

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ABSTRACT

The Nature Conservancy completed an intensive interdisciplinary baseline study, in 1987, of the interdunal ponds within the mesophytic maritime forest of the Nags Head Woods Ecological Preserve, Kill Devil Hills, North Carolina. An ecological symposium on interdunal (swale) ponds was conducted 14 November 1987 to focus attention on these endangered and threatened maritime communities, to compare the biological components of Nags Head Woods ponds with other interdunal ponds, to examine the results of the baseline research, and to discuss a monitoring plan for these systems. The symposium suggested areas of further research and selected species for monitoring.

INTRODUCTION

The importance of the maritime forest ecosystem is underscored by the research and conservation efforts that have been ongoing in Nags Head Woods for decades. The forest of Nags Head is a maritime woodland that lies on the back barrier dunes of Bodie Island straddling the towns of Kill Devil Hills and Nags Head, North Carolina (Fig. 1). Recognized as a nationally significant resource, Nags Head Woods (NHW) was designated a National Natural Landmark in May 1974 and is considered to be the best remaining mature maritime forest on the mid-Atlantic coast (North Carolina Heritage Program 1979). Efforts were undertaken in 1978 by The Nature Conservancy (an international, nonprofit, membership conservation organization committed to the preservation of biological diversity) to protect this nationally significant natural area from threats or encroachment and fragmentation. The Nature Conservancy presently owns and/or manages approximately 304 ha of this 486 ha maritime ecosystem as the Nags Head Woods Ecological Preserve (NHWEP) for conservation, research, and educational purposes.

The natural communities of NHWEP represent high quality endangered woodlands and wetlands preserved as an assemblage of maritime-mesophytic forest ranked S1 (=critically imperiled with five or fewer occurrences in the state), maritime forest (S1), maritime swamp forest (S1), interdunal ponds (S2 = imperiled with 6 to 20 occurrences in the state), or other (S3 = rare with more than 20 occurrences in the state) (Schafale and Weakley 1985), bay forest, pine hammocks, brackish and freshwater marshes, and live and relict dunes (North Carolina

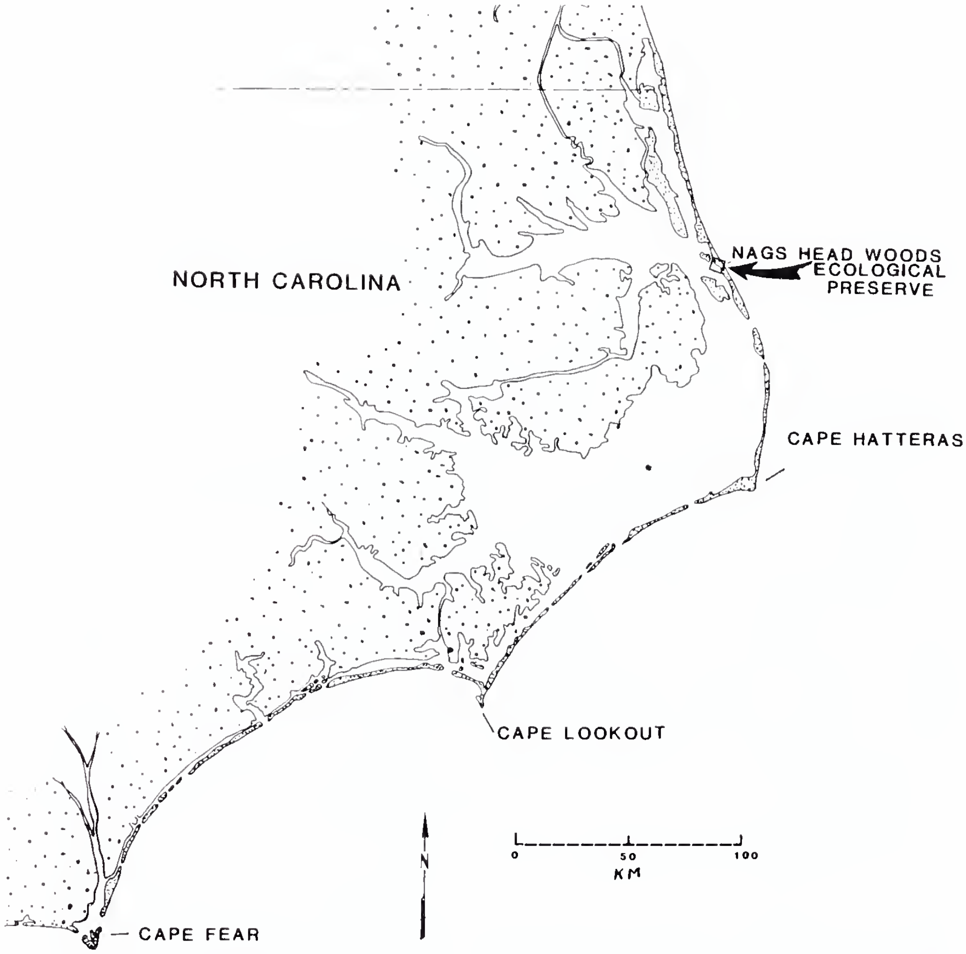

Fig. 1. The coast of North Carolina with the location of Nags Head Woods Ecological Preserve, Kill Devil Hills, Dare County, North Carolina.

Natural Heritage Program 1979). The freshwater interdunal ponds interspersed in the swales of this relic dune field add to the biological diversity of the maritime woodland and are considered vital to the integrity and quality of this ecosystem.

Interdunal wetlands and ponds of NHW were shown in a hydrological study by Whittecar and Salyer (1986) and pond water chemistry study by Kling (1986) to be a reflection of the groundwater table. Fluctuations in the water levels of these wetlands can be directly correlated with the rise and fall of the water table. Groundwater recharge and subsequently pond water levels were dependent upon periods when precipitation exceeds evapotranspiration. "Normal" annual fluctuations within ponds are in the range of one meter (Whittecar and Sayler 1986). The depauperate rain fall conditions of 1985, 1986, and 1987 in the southeastern United States elicited environmental responses not observed in NHW ponds since observations began in 1978. Observations regarding decreased depth and duration of flooding, the encroachment of successional species, and the mortality of large numbers of turtles prompted questions about the health and vigor of the interdunal pond and maritime forest community. Swale ponds are indicative of changes in area hydrology and therefore the quantity and quality of the water in the ponds could be viewed as indices of more systematic problems, much like the "canary in the mine." Therefore The Nature Conservancy initiated baseline research in 1987 on selected interdunal ponds during this drought stress period to determine if significant species were threatened by drought or groundwater table drawdown, to establish drought period papameters for species and communities, and to recommend long term monitoring, management or research needs related to those species or communities. This prompted discussions at an ecological symposium on interdunal ponds.

METHODS

The most effective means for analyzing the status of the Nags Head ponds and defining indicies for monitoring was to conduct an interdisciplinary study, to discuss the initial results, and to define monitoring objectives during an open symposium.

Since many single discipline studies of wetlands can lead to improper extrapolations of data to the entire system (Wilcox 1987), a study embracing nine disciplines was designed and reviewed by a panel of experts. Scientists, in 1987, measured water chemistry and conducted inventories of macroinvertebrates (MacPherson), diatom stratigraphy (Otte and Otte), algal flora (Bellis), vascular flora and vegetation (Davison), ichthyofauna (Schwartz), herpetofauna (Braswell), avifauna (Cooper), and mammalian fauna (Webster). Results were then presented at a symposium 14 November 1987. Two systems ecologists were asked to review the findings. Dr. William Odum compared the interdunal ponds of NHW with those on other barrier islands along the eastern seaboard. Dr. Frank Trama presided over the symposium and provided a summary description of the ponds resulting from the research. Results of the researches are presented in the papers that follow.

RESULTS AND DISCUSSION

Participants analyzed the 1987 baseline data, developed an outline for an initial, long-term monitoring program, and recommended areas for further research of the interdunal ponds in NHW. The 1987 data represented drought conditions, served as a lower threshold of the ecological parameters, and as baseline information for a monitoring plan. No significant species were determined to be threatened by drought or draw down. The inadequacy of single season and drought period collection emphasized the importance and need for long-term monitoring and research (Strayer *et al.* 1986) and the need for a representative, repeatable, and standard procedure to record change along the entire gradient of the system (Johnson 1985).

Three species of herpetofauna were selected by the panel for continued monitoring: the yellowbelly slider (*Chrysemys scripta*), marble salamander (*Ambystoma opacum*), and southern cricket frog (*Acris gryllus*). Criteria developed for selection of species to be monitored were: 1) ease of sampling and identification, 2) direct dependence upon the pond community during at least one stage of their life cycle, and 3) median susceptibility to habitat change. Populations of these species were, in 1987, at adequate levels that could be quantified. Subsequent change in the population of each species could be indicative of a particular change in the habitat.

The monitoring plan for each species will include a definition of the habitat change, as noted by a change in status of each species. The design of the monitoring plan will follow the method of conservation goal setting developed by The Nature Conservancy (Buttick, unpublished ms 1986). The focal point of these plans are the definition of parameters based on baseline data and established management and ecological status goals for monitored species and communities. Thresholds are set to trigger management responses when measured and monitored parameters fall outside defined ecological ranges determined necessary to maintain or improve the status of the species or community. A plan for pond monitoring and management will be developed and administered in 1988 along the lines suggested in 1987.

Three areas of further pond research and inventory were suggested by the panel as follow up to the study. The most important proposal for research was the development of a water budget for the maritime ecosystem. This would delineate the flow between surface (pond) water and groundwater, and aid in understanding the impact of artificial or natural drawdown of the water table on this maritime system. The panel also suggested that complete inventories of the ponds be repeated during a "normal" rainfall period and that rare, relict, and disjunct species found within the maritime ecosystem become the focus of further research.

Acknowledgments

The authors wish to thank all the participants in the study and the staff of the Nags Head Woods Ecological Preserve for their intense labor toward this project. We extend a special thanks to Steve Buttrick, who made the trip down, and to Bill Rose, Frank Schwartz, and Margit Bucher, who were extraordinary during the crisis times of this project.

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BARRIER ISLAND INTERDUNAL FRESHWATER WETLANDS

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ABSTRACT

Interdunal, freshwater wetlands and ponds, such as those found at Nags Head Woods, are associated with many of the larger barrier islands on the southeastern and Gulf coasts of the United States. Typically, these occur where: (1) dune and swale topography has persisted since at least the mid to late Holocene (2,000–5,000 years B.P.), (2) a lens of fresh groundwater intersects the bottoms of the swales, and (3) extensive flooding by seawater is infrequent. These freshwater wetlands are contrasted with the more common brackish, interdunal wetlands found on barrier islands which have relatively recent dune and swale topography, lack a permanent connection to the freshwater lens, and are more frequently flooded with seawater. Finally, we compare physical and biological characteristics of other interdunal, freshwater wetlands with those at the Nags Head Woods.

INTRODUCTION

Freshwater wetlands located in the swales between relict dune ridges are relatively common on the barrier islands of the southeastern and Gulf coasts of the United States. These interdunal or swale, freshwater wetlands have been little studied and are poorly described in the literature. According to our observations, they occur at locations such as Chincoteague Island, Virginia, Cumberland Island, Georgia, and St. Vincent's Island, Florida, where dune ridge and swale topography has persisted since the Holocene. We believe that the critical requirement for the existence of this wetland type is the presence of a lens of fresh groundwater which intersects the bottom of the dune swales, at least seasonally.

We summarize in this paper some of the geological, hydrological, and ecological characteristics which are common to most barrier island, interdunal freshwater wetlands. Next, these general characteristics are compared with those found at the ponds and wetlands of Nags Head Woods (NHW) to determine if the latter has any unusual features. Finally, it is emphasized that all interdunal, freshwater wetlands are extremely fragile, easily disturbed by human activity, and must be managed carefully to avoid irreversible damage.

GEOLOGICAL SETTING

Almost all of the freshwater interdunal wetlands on the Atlantic and Gulf coasts are associated with islands which were formed during the Holocene, 2,000 to 5,000 years ago. This was a period of lower but rising sea level and abundant sand supplies (Halsey 1979; Kraft *et al.* 1979). Because of the combination of slowly rising sea level and plentiful sand, the formation of dune ridges parallel to the islands' coasts was common. Areas of rapid sand accretion resulted in wide islands consisting of multiple, parallel ridges, while slower accretion rates led to the development of narrower islands with few ridges.

As the islands widened, the earlier dune ridges were located further and further towards the island center and became covered with terrestrial vegetation which acted to stabilize them. Also as islands widened, unconfined, freshwater aquifers developed through recharge by local rainfall. If an island was large enough and precipitation exceeded evapotranspiration, the unconfined freshwater aquifer became sufficiently thick and extensive to intersect the bottoms of the dune swales and form interdunal freshwater wetlands.

Since the Holocene, many of these ridge and swale features have persisted with only minor modifications. For example, on Chincoteague Island, Virginia, the basic topography remains with a dozen or more parallel ridges and swales, some of which exceed a kilometer in length (Odum *et al.* 1986). At this location, a combination of erosion on the north end of the island and rising sea level allowed intrusion of brackish water some distance toward the center of the island along some of the swales. This led to interdunal wetlands characterized by brackish vegetation such as salt grass (*Distichlis spicata*), marsh hibiscus (*Hibiscus moscheutos*) and seashore mallow (*Kosteletzkya virginica*). Towards the center of the island, the interdunal wetlands are largely freshwater and support freshwater plant species and even swamps are dominated by trees such as red maple (*Acer rubrum*).

At many other sites (e.g. Nags Head Woods, North Carolina, and Cumberland Island, Georgia) the ridge and swale topography has been dissected at right angles by drifting sand or later beach ridge formations (e.g. St. Vincent's Island, Florida) to form chains of isolated wetlands which may be any shape ranging from linear to tear-drop or circular. The end result is a complex pattern of Holocene ridge and swale topography with wetlands in the swales and terrestrial vegetation on the ridges.

Ridge and swale topography has formed in some locations in more recent times (i.e. the last few hundred years). For this to occur, there must be large supplies of sand present and rapid accumulation occurring along the beach. An example is Fisherman's Point at the south end of Assateague Island, Virginia, where a series of low-lying beach ridges and swales have formed since 1900. Usually these recent examples of ridge and swale terrain are relatively ephemeral, modest in extent, not well stabilized with vegetation, and frequently subject to oceanic overwash resulting in brackish or even hypersaline interstitial pore waters (Schneider 1984).

In this paper, we have omitted further discussion of the usually brackish ponds and wetlands associated with recent dune and swale topography (see Ranwell 1972 for a discussion). Instead, the focus is on sites such as Nags Head Woods which are usually freshwater and have persisted since at least the late Holocene.

CHARACTERISTIC FEATURES

Subsurface Hydrology

Although complete, published documentation is lacking, it appears that most interdunal freshwater wetlands owe their existence to a subsurface hydraulic connection with the barrier island's water table aquifer. It is possible that there are saturated wetland soils which are "perched" above the water table aquifer in small basins sealed by accumulated organic matter (see Timms, 1982 for a description of this type of interdunal wetland in Australia), but this mode of persistence is probably an exception.

Lenses of freshwater may be extremely shallow and disjunct on barrier islands (Winner 1975, 1978). On some islands the lens floats on top of layers of brackish water beneath only the highest dunes while on others the freshwater lens may be 5–10 m thick and relatively continuous and underlain by confining layers of clay or organic soil. For example, on Chincoteague Island, Virginia, the lens is largely brackish water and has only isolated and very thin layers of freshwater a meter or less in thickness (H. G. Goodell, pers. commun.) whereas on wider portions of Hatteras Island, North Carolina, the water table aquifer is fresh throughout its 10 m depth (Bolyard *et al.* 1979).

The mechanics of the hydraulic connection between the interdunal ponds and wetlands and the water table aquifer have not been studied at most locations. Personal observations at a number of locations on the U.S. east coast indicate that the bottom of the interdunal wetlands appear to be partially sealed off by a mixed layer of sand, silt, and organic matter which has a low hydraulic conductivity (i.e. vertical water movement is very slow). Exchange of water in this case is probably most important around the edge of the swale with lesser amounts moving through the swale's bottom.

Both interdunal wetlands and water table aquifers appear to be functionally linked to climatic fluctuations. Consideration of this linkage leads to the following hypotheses:

(1) Freshwater interdunal wetlands will not exist in regions where evapotranspiration exceeds precipitation (e.g. Padre Island, Texas). (Note that drilling artesian wells into deep freshwater confined aquifers could create artificial interdunal freshwater wetlands under these conditions.)

(2) Interdunal wetlands may exist in regions where precipitation exceeds evapotranspiration, but water levels will fluctuate with climatic fluctuations.

(3) This means that interdunal wetland water levels will vary annually. Typically, maximum depths will occur in the fall, winter, and spring and minimum depths in late summer. This annual variation may be on the order of one meter.

(4) There will be long-term variations in summer water levels in response to drought cycles in the southeastern United States. The result is usually a severe drought at least every two decades resulting in severe depression of the water table aquifer and total drying-up of most interdunal wetlands.

(5) If the water table aquifer is contaminated by saltwater during flooding and oceanic overwash, then the interdunal wetlands will also become brackish. It may take years for this linked hydraulic system to be totally flushed by rainwater. Such periodic incursions of brackish water are typical on many low-lying barrier islands (e.g. Ocracoke Island, North Carolina).

(6) Interdunal freshwater wetlands are best developed and most persistent at locations such as Nags Head Woods where island width and Holocene dune topographic relief is greatest (i.e. where maximal storage volume for recharge exists). High dune ridges also resist oceanic flooding and overwash and lower the probability of saltwater contamination of the water table aquifer.

In summary, the presence of interdunal freshwater wetlands closely reflect controls on the volume and freshwater character of the associated water table aquifer. Conditions in the latter control the hydroperiod which affects vegetation and biological processes within the swales. As mentioned later in this paper, human-induced changes in the aquifer or the swale wetlands will affect the other component.

Water Quality

The water chemistry of interdunal ponds is highly variable from one location to the next depending upon local factors such as the geological composition of nearby sand dunes, the degree of leaching of these dunes, the water chemistry of the water table aquifer, inputs from salt spray, the amount of organic matter input, etc. However, based on personal observations and several published studies (e.g. Kling 1986; Odum *et al.* 1986) there appear to be some trends in water quality which can be expected at many sites which are not subject to periodic oceanic flooding and overwash.

Most interdunal ponds seem to have ionic concentrations slightly higher than typical inland freshwater ponds. Kling (1986) reports conductivities ranging from 112 to 381 μS cm^{-1} for five ponds at Nags Head Woods. This is in the range which we have noted at other sites along the coast. Presumably, these result from a combination of salt spray inputs, leaching of ions from nearby sand, and evaporative concentration. Interdunal ponds, in spite of these inputs, typically do not have excessive amounts of nitrogen and phosphorous and usually would not be classified as eutrophic. An exception to this generalization occurs if bird rookeries and nesting areas are located in or near the pond. Under these conditions, the interdunal ponds can become excessively eutrophic, particularly during periods of low water levels.

Interdunal ponds tend to be circumneutral in pH (Kling 1986). However, if large amounts of macroalgae are present in shallow ponds, the pH may be as high as 9.0 during the middle of the day. Conversely, if large quantities of humic substances and organic acids are present from decaying vegetation, the pH may be as low as 4.5 during later summer periods of low water.

Probably the most characteristic feature of interdunal ponds is their tendency to collect quantities of decaying plant detritus in an amorphous layer on and near the bottom of the pond. During the summer, this often results in virtually no dissolved oxygen in the pond's bottom water and relatively little in the surface water. Further, it creates anaerobic conditions in the bottom sediments which lead to significant changes in interstitial pore water chemistry and, ultimately, the subsurface hydrologic properties of the sediments. It seems likely that the periodic drying of interdunal ponds and subsequent oxidation of these bottom sediments and their accumulated organic matter probably prevents the ponds from eventually becoming totally filled with organic matter.

Vegetation

Based on observations of a number of barrier island sites along the south Atlantic coast, vegetation in interdunal wetlands falls into five categories; rarely are all five found in the same location. If an open water pond is present and if water clarity is sufficient there may be (1) submerged aquatic plants such as species of *Chara, Nitella, Najas,* and *Vallisneria.* If open water persists through most of the year then (2) floating aquatic plants such as *Utricularia* spp. and *Wolffiella* spp. will be present. Most interdunal wetlands are dominated by (3) emergent species. These include graminoids such as species of *Scirpus, Carex,* and *Eleocharis* and herbaceous plants such as species of *Sagittaria, Polygonum,* and *Sparganium.* (4) Shrubs including species of *Myrica* and *Rosa* are usually present if water depths are not too great. Finally, (5) swamp trees such as *Acer rubrum, Liquidambar* *styraciflua,* and *Nyssa sylvatica* var. *biflora* may occur if hydrologic conditions are suitable. Vegetation surrounding interdunal wetlands ranges from simple dune vegetation dominated by grasses, herbs, and shrubs to complex maritime forests.

Clearly, the pattern of vegetation which is found in specific interdunal wetlands is often complex and reflects past trends in climate, storm occurrence, dune migration, and hydrology. The most important factor, as in all wetlands, is the local hydrology and how that has varied in recent history (Mitsch and Gosselink 1986).

Wetland Classification

Using the system of Cowardin *et al.* (1979) most freshwater interdunal wetlands would be classified as: (1) palustrine emergent, (2) palustrine scrub/shrub, or (3) palustrine forested. For cases not reviewed in this paper where some connection with the sea exists, the wetlands might be classified as: (1) estuarine emergent, or (2) estuarine scrub/shrub depending upon the vegetation which is present.

NAGS HEAD WOODS: AN EXAMPLE OF INTERDUNAL WETLANDS

The ponds and wetlands of Nags Head Woods are a typical example of freshwater interdunal wetlands. They lie in the swales between Holocene dune ridges (Dolan and Hayden, unpublished ms.) and are hydrologically linked to the water table aquifer (Whittecar and Salyer, unpublished ms.). Pond water is usually circumneutral, relatively high in dissolved ions and low in oxygen in the late summer (Kling 1986). Vegetation ranges from floating aquatic plants to emergent grasses, shrubs, and even swamp trees (Otte *et al.,* unpublished ms.).

However, the Nags Head system is unusual in some respects. The number of ponds and wetlands is high compared to most barrier islands. This is related to the complex topography and exceptional topographic relief created by numerous migrating dunes of fairly recent origin which have moved across the original elongated Holocene dune swales creating multiple smaller basins. The result is a plethora of small ponds and wetlands, many of which are almost circular. Connected to these basins is an extremely well developed water table aquifer which slopes outward and downward from the center of the island (Whittecar and Salyer, unpublished ms.) and keeps the ponds flooded except during the most severe droughts. This, in turn, has resulted in an unusually diverse animal community compared to many other interdunal wetlands, especially in terms of amphibians (Braswell 1988) and fishes (Schwartz 1988).

Another noteworthy feature of the Nags Head interdunal system is the presence of a well developed maritime forest. While maritime forests are certainly present at other sites which have interdunal wetlands, the degree of development, the extent and the amount of relatively unaltered forest are unusual.

Two of the most significant features of the NHW are: (1) its protected status gained primarily through efforts of The Nature Conservancy and (2) scientific investigations promoted by the same organization make it one of the best studied interdunal wetland sites in North America (see other papers in this issue).

PROTECTIVE MANAGEMENT

From the preceding discussions it should be evident that management of interdunal wetlands has two major objectives: protection of the dune/swale systems from direct alteration and protection of the barrier island's water table aquifer. Protection from direct alteration means preventing developers and road builders from bull-dozing the dunes into the swales to create flat developed tracts of land or dredging and deepening the swales to form artificial ponds and waterways. These types of activities have occurred on many barrier islands (e.g. Hilton Head, South Carolina, Chincoteague Island, Virginia) with the result that many interdunal wetlands simply don't exist or have been transformed into golf course water hazards.

More subtle are cases in which interdunal wetlands have gradually dried-out or become saline through salt water intrusion as water is withdrawn from the water table aquifer for purposes such as irrigating lawns and golf courses. Typically, withdrawal of large volumes of water near an interdunal wetland will lower the water table substantially. Even though much of this irrigation water will return to the water table, the landward and upward readjustment of the brackish-freshwater interface near the pumping site cannot be easily prevented. This means that interdunal wetlands which appear to be well protected ultimately may be altered and destroyed by withdrawals of water outside the protected area.

Another threat to interdunal wetlands is replacement of natural vegetation by invading "disturbance species" such as *Typha* spp. and *Phragmites communis.* Once established, these plants are difficult to control or eradicate. Invasion typically follows disturbances such as dredging, filling or artificial changes in water level.

In conclusion, it appears that freshwater interdunal wetlands, such as those found in the NHW, are an unusual and fragile resource. While they occur on a number of barrier islands in the southeastern United States, they are sufficiently varied and limited in total area to warrant extreme efforts for their preservation and management.

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ENVIRONMENTAL PARAMETERS OF NAGS HEAD WOODS PRESERVE PONDS

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ABSTRACT

Seven baseline studies had been conducted on the Nags Head Woods Ecological Preserve prior to the summer 1987 investigations. Their focus was to compare the paleoecology of this woodland with the present vegetative communities in order to determine the stability of the existing forest cover by establishing the successional pattern leading to its current composition. By obtaining this information, management efforts could be directed towards the most ephemeral plant communities. Year-round aquatic habitats of the interdunal swales were the most recent addition to the diverse communities of the Woods. Wetlands created by freshwater rising atop a mounting sea level to flood the land surface were first established in these areas approximately 1,500–3,000 yr ago. The ponds however did not become permanent until approximately 400 yr ago. The upland *Pinus-Quercus-Carya* forest community has remained essentially unchanged since the permanent inundation of the swales. The ponds consist of groundwater recharged by precipitation during periods when rainfall exceeds evapotranspiration. Pond levels have lowered because of recent droughts. Such events may cause a reversion of habitat to more xeric conditions.

INTRODUCTION

The Nags Head Woods Preserve (NHW) occupies an area on Bodie Island, the northernmost barrier island on the North Carolina coast. The Woods straddle the boundary between the western sections of the towns of Nags Head and Kill Devil Hills. The North Carolina Natural Heritage Program has classified the NHW plant community as a maritime-mesophytic forest, the only one of its type in North Carolina. The area has also been designated by the United States Congress as a National Natural Landmark.

The Nature Conservancy has acquired 162 ha of this unusual 486 ha woodland and designated it the Kill Devil Hills Research Area. The Conservancy's staff, at Nags Head Woods Ecological Preserve, manage an additional 142 ha owned by the town of Nags Head as part of the Preserve and has developed passive recreation opportunities there. The area is also protected as a watershed for a municipal drinking water reservoir.

An education/research center was constructed by The Nature Conservancy on a previously disturbed site that had been platted and landscaped for a housing development. Center staff uses research findings in an education program directed to encourage public support for protecting the NHW. Research is aimed at detecting and mitigating negative impacts to the NHW natural system.

Reviewed herein are preliminary investigations that canvassed the uniquely mesic nature of the NHW. This analysis of existing data was done to provide a background template against which to judge the findings of the limnological studies conducted during the Spring–Summer of 1987. These investigations served as the basis for management decisions giving first priority to determining the health and viability of the forest's aquatic systems.

METHODS

Following the completion of acquisition activities, the staff began to develop baseline data necessary to make responsible management decisions. Botanical, limnological, and zoological studies were conducted by professionals. Recommendations from those studies were evaluated in order to decide how to manage and monitor continuing programs.

Basic inventories and mapping utilized the Natural Heritage Classification System (Radford *et al.* 1981) to provide an accurate, quantifiable description of the Nags Head Woods natural system (Otte *et al.* 1985).

A paleoecological study of pond sediments determined recent historical progression of the forest (Burney and Burney 1984, 1987). Concurrent with this study, the physiochemistry of the ponds was described by Kling (1986).

Land managers and volunteers at the preserve have also examined the relationship of open water ponds with the groundwater table. Through correlating fixed staff gauge readings of pond levels with measurements taken in shallow wells adjacent to the ponds, they established a close tie between pond levels and groundwater elevations.

A 1986 hydrogeology study employed weekly readings at deep wells installed around the periphery and throughout the Woods to obtain a picture of the groundwater table. Pump tests determined hydraulic conductivity and the impact of drawdown by an adjacent municipal water system (Whittecar and Salyer 1986).

RESULTS

Topography and Soils

Otte *et al.* (1984, 1985) in their natural heritage inventories described the Nags Head Woods topographically as a stabilized portion of the Nags Head Dune Field, flanked on the north, south, and east by active and semi-active eolian dunes. A 34 m sand dune, Jockey's Ridge, formed the southern boundary of the Woods and the 18 m Run Hill bounded its northern limits.

Two smaller dune systems within the Woods are divided by one large, complex forested "star" dune with a crest 27 m above mean sea level (MSL). The Kill Devil Hills Research area, owned by The Nature Conservancy lies between this dune and Run Hill (Fig. 1). The topography consists of a series of three north/south elongated forested dunes, with crests ranging from 6–15 m above msl. These dunes appear to have been moving westward until stabilized by natural processes of plant succession (Otte *et al.* 1985). The eastern-most dune is gently sloped on its eastern windward face. Its crest is approximately 1,523 m west of the ocean shoreline and provides a protective barrier for the interior woods against damaging wind-borne salt-mist. The central dune is ill-defined and has numerous east/west oriented feeder dunes which have apparently been overridden in some locations by advances of the eastern dune. The southern end of this central dune has dissipated to create several smaller dunes that sprawl over interdunal flats. The steep face of the western dune overlooks swamp forest and marsh to the west. Its eastern slope is gentle and has several east/west feeder dunes that spread eastward across interdunal flats.

The sandy soils of the dunes are very porous and permeable fine to medium grain, predominately quartz. Despite its porosity, a shallow water table and upward capillary movement of water prevent the top meter of soil from drying out, except in large open areas. Capillarity in these fine-grain sands lifts adequate moisture from the groundwater table to maintain mesic and dry-mesic communities even on dune slopes. The sands underlying the NHW exhibit minimal soil horizon development. Some leaching occurs in the topmost 0.5 m of dune surfaces. Con-

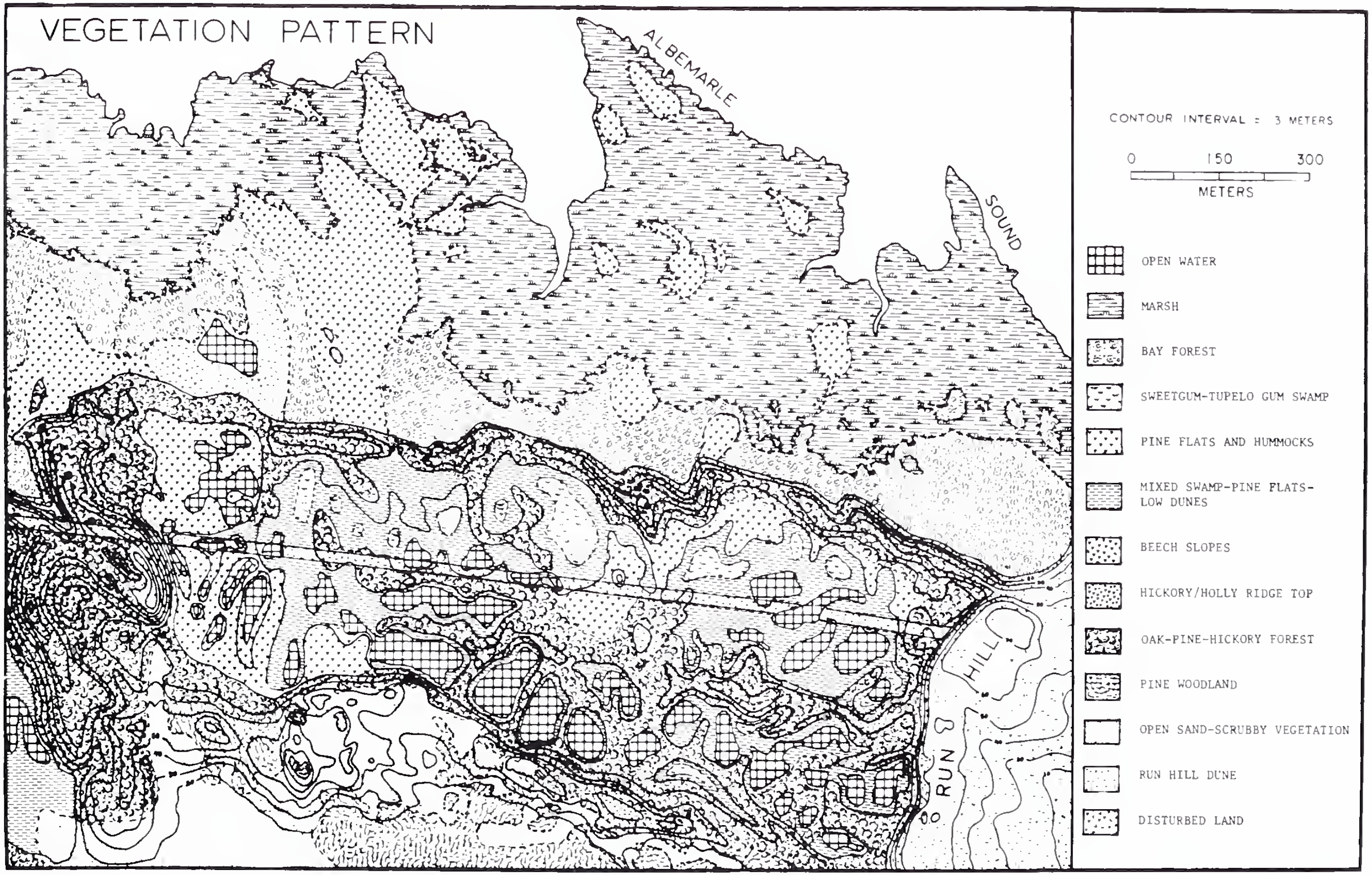
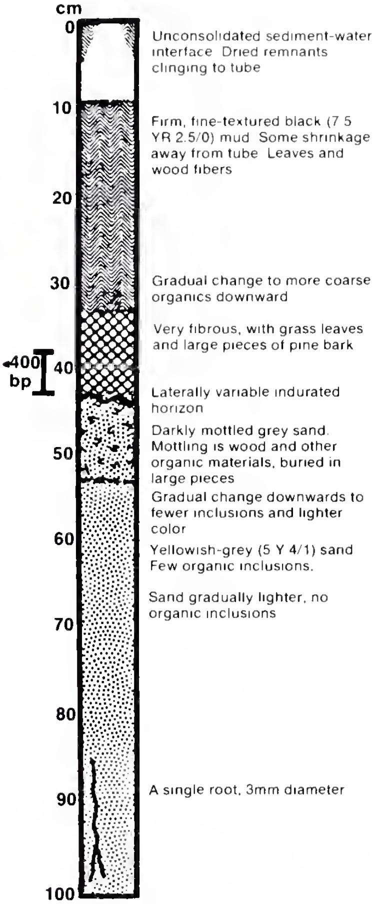


Fig. 1. Vegetative communities of the Nags Head Woods Ecological Preserve—The Nature Conservancy (Otte *et al.*, 1985).



Unconsolidated sediment-water interface Dried remnants clinging to tube

Firm, fine-textured black (7 5 YR 2.5/0) mud Some shrinkage away from tube Leaves and wood fibers

Gradual change to more coarse organics downward

Very fibrous, with grass leaves and large pieces of pine bark

Laterally variable indurated horizon

Darkly mottled grey sand. Mottling is wood and other organic materials, buried in large pieces

Gradual change downwards to fewer inclusions and lighter color

Yellowish-grey (5 Y 4/1) sand Few organic inclusions.

Sand gradually lighter, no organic inclusions

A single root, 3mm diameter

Fig. 2. Sediment core from Nags Head Woods Ponds (Burney and Burney 1984).

centrating iron oxides may initiate the development of a spodic horizon within the zone of water table fluctuations in the interdunal flats. A thin layer of organics is developing and some organic stain sands are evident in interdunal wetlands (Otte *et al.* 1984).

Burney and Burney (1984) profiled the sediments underlying the ponds within the interdunal wetlands (Fig. 2). Below the sediment/water interface, they found approximately 10 cm of unconsolidated material, grading into fine-grained black mud containing tree leaves and wood fibers to a depth of about 33 cm. The lower 10 cm of this fine-grained mud was a layer of fibrous material including large pieces of pine bark, carbonized wood, and grass leaves. Below the mud, dark grey sand extended approximately 52 cm, and is mottled with 1–4 cm fragments of apparently buried tree branches. The mottled area grades, at 100 cm, into a clean yellowish-grey sand with few organic inclusions.

Whittecar and Salyer (1986) found poorly-sorted silty sands containing shell fragments and some thin interbedded clayey silts 1–8 m below the dunes of NHW (Fig. 3). The bottom of the groundwater aquifer between depths of 8 and 20 m is marked by a compacted layer of dark green clay.

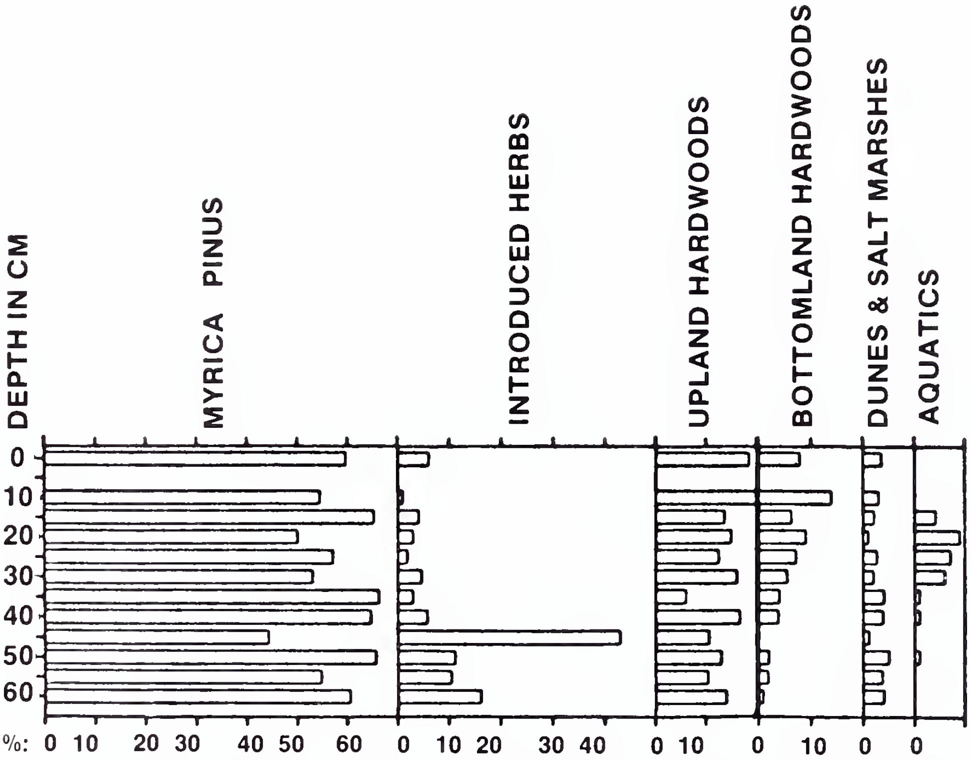


Fig. 3. Synoptic pollen diagram of core from Nags Head Woods Ponds (Burney and Burney 1984). Left to right: Tidal marsh, Bay forest; open sand dune (open sand-scrubby vegetation, Run Hill dune); Forested dunes (Beech slopes, Hickory-Holly ridge, oak-pine-hickory forest); Forested Interdunal flats (Sweetgum-Tupelo gum swamp) Pine flats and hummocks, mixed swamp-pine flats-low dunes, Pine woodland, disturbed land); and open water ponds.

Vegetation

The NHW complex can be divided into six major habitat types: tidal marsh, bay forest, open sand dune, forested dunes, forested interdunal flats, and open water ponds (Fig. 1; Otte *et al.* 1985). These can be subdivided into numerous vegetative communities. Discussion will focus on the plants in and around the open water ponds and the adjacent forested dunes and interdunal flats of the NHW.

The forested dunes are situated topographically, high with respect to the other environments, and are well drained and aerated at all times. The major kinds of communities range from dry mesic to mesic and have canopies dominated by varying mixtures of *Quercus falcata* (southern red oak), *Q. laurifolia* (laurel oak), *Carya ovalis* (sweet pignut hickory), *Fagus grandifolia* (American beech) and *Pinus taeda* (loblolly pine). The Kill Devil Hills Research Area is more mesic than elsewhere in the NHW and includes a greater abundance of *F. grandifolia, Q. laurifolia, Ostrya virginiana* (hop hornbeam), and *Carpinus carolinianus* (ironwood) (Otte *et al.* 1985).

The forested interdunal flats occur in topographically low areas with water above, at or near the ground surface, during most of the year. These flats range from hydric to wet mesic and have canopies dominated by mixtures of *Pinus* *taeda, Nyssa sylvatica* var. *biflora* (swamp tupelo) and *Liquidambar styraciflua* (sweetgum) (Otte *et al.* 1985).

Thirty-three to 36 open permanent or semi-permanent ponds are found within the Kill Devil Hills Research Area of NHW. They range in size from 0.1 to 1 ha. Most of the ponds are oriented east/west between small east/west feeder dunes. A few ponds are located between smaller finger dunes radiating south from the large central dune. Ponds less than 0.2 ha contain vegetation similar to deeper portions of interdunal swamps in the Woods. Larger ponds are rimmed with bottomland tree species but most of their surface area is open to sunlight. These larger ponds are bordered on most sides by steep dunes rather than interdunal flats.

Four vegetational zones encircling the ponds can be described. Although often indistinct and grading from one to the other, separate characteristics can be isolated: 1. a tree zone dominated by *Nyssa sylvatica* var. *biflora* (swamp tupelo), and *Liquidambar styraciflua* (sweetgum); 2. a shrub zone dominated by *Myrica cerifera* (wax myrtle) and often *Decoden verticillatus* (water loosestrife); 3. a zone of emergent rooted aquatics contains primarily *Hydrocotyle ranunculoides* (water pennywort), *Saururus cernus* (lizard's tail), *Thelypterus palustris* (marsh fern) and *Osmunda regalis* var. *spectabilis* (royal fern); and 4. a zone of floating aquatics dominated by *Wolffia columbiana, Spirodella polyrrhiza,* and *Wolfiella floridana.*

Few ponds contain all four zones. The pattern of zonation is dependent upon shoreline characteristics and hydroperiods (Otte *et al.* 1985).

Water Chemistry and Hydrology

Kling's (1986) chemical analysis supported conclusions drawn from water level studies indicating that the ponds comprise exposed groundwater. He found that the ionic composition of pond water was similar to that of the underlying NHW groundwater.

Whittecar and Salyer (1986) determined that the crest of the groundwater table was usually centered 400 m east of Fresh Pond and flowed westward at a rate of 9×10^{-5} m/s to 6×10^{-5} m/s in and out of the ponds of NHW in route to Roanoke Sound. Incorporating the effects of rainfall, evapotranspiration, and interception, they produced a computer model of groundwater recharge in NHW. When evapotranspiration rates were plotted against average monthly precipitation for the years 1976–1985, recharge occurred from June to August only if precipitation was excessive (Whittecar and Salyer 1986).

Based on Whittecar and Salyer's model, recharge under conditions of "normal" precipitation occurred primarily during the months of November through March. They predicted that abnormally low groundwater levels in August will follow unusually low winter and spring rainfall. High groundwater levels would follow wet springs and summers. The widest range in water levels between these extremes was estimated to be 1.5 m. Under "normal" conditions, groundwater level should fluctuate one meter over a year's time.

Pond water levels measured since 1981 have approached both extremes of Whittecar and Salyer's model. Between October 1981 and October 1983, pond water levels never fell below 2 m above msl. Pond levels dropped below this elevation for 22 weeks of the 24 months recorded between October 1985 and October 1987. The maximum height between October 1981 and October 1983, was 2.9 m above msl and levels dropped below 2.4 m for only one week out of the 24 month observational period. For the period October 1985 to October 1987, the highest recorded water level was 2.6 m above msl; levels remained below 2.4 m msl for 21 of the 24 months. Drought not only lowered the annual high water level, but reduced pond surface area and pond margin hydroperiods. Ponds in NHW have shrunk approximately 25% between December 1986 and December 1987. Exposed pond margins have grown by a similar proportion.

DISCUSSION

Review of available data by Preserve staff enable postulation of a biogeomorphic history of NHW. Shell fragments and interbedded clayey silts found in sediments at 1–8 m below the ground level by Whittecar and Salyer (1986) are unsorted and judged to have been deposited in quiet waters either offshore marine or estuarine in origin. It is possible that these sediments could have been laid down during an interglacial period of the Pleistocene Age that ended approximately 30,000 yr ago. Subsidence of the interglacial coastal plain flooding exposed these sediments, and they became subject to burial by large sheets of overwashed and wind-sorted sand.

The world's oceans began rising rapidly 20,000 yr BP. NHW, by 8–10,000 BP was joined together with Colington Island as a single island located in an estuary at the mouth of what was then Albemarle River. North Carolina's barrier islands were separated from the mainland at that time and much farther out to sea than in more recent periods (Pierce 1969; Pierce and Colquhoun 1970). The barrier islands migrated westward before a rising ocean, and between 4,000–5,000 yr BP collided with the theoretical Colington/Nags Head Woods Island. This area then formed the north bank of an inlet on the consolidated barrier island (Riggs *et al.* 1978). The inlet, known as Roanoke Inlet, remained open until the early 1800's (Stick 1958).

Origins of the present forest followed initial stabilization of windblown sand which was wetted by groundwater rising above the surface atop the mounting sea level. Accumulation of water in dune swales began the formation of interdunal wetlands. The modern-day depth of water and sediment in most of the interdunal wetlands in NHW is about 1.5 m. According to accepted theories of sea level rates of change, these ponds may have had their beginning some time between 1,500 and 3,000 yr BP (Otte *et al.* 1984).

Carbon dating of pond sediments in the Kill Devil Hills Research Area of NHW place them between 400 and 800 yrs old. Paleoecological correlations have established that by 400 yrs BP, the NHW were already forested by an upland angiosperm forest. Seventeen percent of all pollen sampled throughout the core was comprised of species such as *Quercus, Carya, Castanea,* and *Ostrya-carpinus* (Fig. 3). Pollen from aquatic species or bottomland angiosperms was not in evidence during this time period (Burney and Burney 1986).

A subsequent decrease in the proportion of pines and an increase in the percentage of hickory was the only change in the upland plant communities noted. The pollen record indicates a gradual die-off of vegetation in swale bottoms as they filled with water and were invaded by *Typha* spp., *Utricularia* spp., and *Potamogeton* spp. Slowly, the ponds became deep enough to provide year-round aquatic habitat. The pollen samples reveal the gradual disappearance of emergent vascular freshwater species and an increase in the bottomland hardwoods (Burney and Burney 1986). We conclude that a pine-oak-hickory forest preceded the establishment of permanent ponds and aquatic vegetation in and around the ponds changed as depth increased. The composite picture provided by this pollen analysis was one of a stable, maturing upland forest and with ponds in the low-lying areas expanding in response to rising sea level.

ACKNOWLEDGMENTS

These research projects could not have been completed without the generous financial and staff support of the Friends of Nags Head Woods. The researchers themselves also deserve a great deal of thanks for including extra aspects in their projects and receiving minimal compensation. Special thanks also goes to the staff of The Nature Conservancy and in particular Bill Rose, Carol Mayes and Katherine Howd for their continued guidance and support. As well, Drs. Vince Bellis and Frank Schwartz deserve our gratitude for their patience as counselors in helping bring this project to fruition.

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MICROALGAE OF BARRIER ISLAND FRESHWATER PONDS, NAGS HEAD, NORTH CAROLINA

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ABSTRACT

A qualitative survey of microalgae in four fresh ponds on a barrier island revealed a diverse flora dominated by periphytic diatoms, desmids, and euglenoids. Most of these taxa are motile unicells that reproduce rapidly by asexual means and produce resistant spores or mucilage invested cysts conducive to survival during periods when the ponds become dry. Several of the more abundant desmids and diatoms have been cited in the literature as indicators of low mineral content water. The generally oligotropic nature of these ponds was further indicated in that the algae seldom formed conspicuous masses even though 100 × microscope fields seldom contained fewer than five separate taxa. The trophic significance of these algae with respect to other organisms in the ponds, or with the surrounding forested dunes, has not been quantified. That these algae may perform an important nutritive role in a pond ecosystem is indicated as several of the relatively abundant cyanophytes including *Anabaena, Nostoc,* and *Tolypothrix* are known nitrogen-fixers.

INTRODUCTION

Freshwater ponds are ecologically important but seldom studied components of barrier island ecological systems. They may serve, in addition to their obvious significance as a source of potable water for terrestrial organisms, as important resting stops for migrating animals or as refugia for aquatic insects or other invertebrates. Organisms inhabiting barrier island ponds may periodically be exposed to episodes of elevated salinity, when storms deliver salt aerosols from the ocean, or evaporation during seasonal or longer period droughts.

Microalgae are ubiquitous, but seldom conspicuous, components of barrier island ponds. Since specific microalgae are often indicative of ambient physical/chemical conditions, algal floristics can serve to infer prevailing environmental conditions at a given location and as a basis for detecting long-term changes.

The present study reports results of a survey of freshwater algae in four interdune swale ponds located in the Nags Head Woods Nature Preserve (NHW) managed by the North Carolina Nature Conservancy. This survey defined algal microhabitats within these ponds, identified the dominant algae in each microhabitat, evaluated the functional role of algae within the pond ecosystem, and identified adaptive features of the pond algae which were indicative of environmental conditions prevailing in the barrier island ponds.

METHODS

Four ponds within the NHW represented the range in hydrological conditions "normally" prevailing at the study site. Algal collections were made from each pond in June, August, and September, 1987. An attempt was made to sample conspicuous microhabitats in each pond. Periphyton was recovered by squeezing aquatic vascular plants or detritus over an open plastic bag. Soft benthic samples were recovered with a pipet. Phytoplankton was recovered, in the few instances when there was a sufficient depth of water to pull a net, with a 0.15 mm mesh phytoplankton net. Samples were stored in one-pint plastic freezer bags in an ice chest cooler for transport back to the laboratory. Aliquots from each sample were preserved, in the laboratory, in Transeau's 6-3-1 solution (Prescott 1979) while additional aliquots were treated with boiling acid to prepare diatoms for mounting (Patrick and Reimer 1966). A third aliquot of the living sample was maintained for several weeks in a plant growth chamber (14 h light/10 h dark, 15 C).

Identifications were made using fresh, preserved, and specially mounted material. Microscopic examinations were made using a Nikon Model L-ke microscope and images of selected taxa were recorded on Kodak ET-135 film. All preserved collections, prepared diatom mounts, and 35 mm color slides have been deposited in the algal herbarium at East Carolina University.

RESULTS AND DISCUSSION

Algal microhabitats, identified at the study ponds, included neuston, plankton, endosymbionts, epizoics, benthos, and floating mats; however, periphyton attached to aquatic vascular plants and detritus was the most widespread and consequently the most frequently sampled microhabitat. Except for occasional floating mats of filamentous blue-green algae (*Tolypothrix*), filamentous green algae (*Spirogyra, Hyalotheca,* and *Rhizoclonium*), or filamentous diatoms (*Eunotia* and *Fragilaria*) accumulations discernable to the naked eye were seldom evident. However, macroscopic examinations of living and dead submerged surfaces revealed an abundance of motile and attached unicells. Diatoms, desmids, and euglenoids were especially well-represented in scraped or squeezed samples from such locations. Phytoplankton samples usually contained flagellated colonial volvocoids (*Pandorina* and *Eudorina*), euglenoids (*Phacus, Lepocinclis, Trachelomonas*), or the chloromonad *Gonyostomum semen.* Phytoplankton taxa may be underrepresented in this study because unusually severe drought conditions had eliminated standing water in several of the ponds. It is doubtful if a true plankton occurs in the study NHW ponds as they are very shallow. Taxa recovered by the plankton net were usually the same as those of the periphyton.

The dinoflagellate *Ceratium hirundinella* was encountered in low density among the plankton in Frog Pen Pond. Later in the summer this alga formed a macroscopic brown colored bloom in an adjacent unstudied pond.

Occasionally, a green film was evident on some pond surfaces, when viewed at an oblique angle. This film appeared to contain the green alga, *Botryococcus.* This colonial alga harbors gas bubbles trapped within the mucilage binding the cells together. Individual colonies of *Botryococcus* do not break the surface tension of the water and thus represent an neustonic community.

Extensive growths of the floating mosquito fern, *Azolla caroliniana* were observed on several ponds. All samples of *Azolla* examined contained filaments of a nitrogen-fixing endosymbiotic blue-green alga, *Anabaena azollae.* An epizoic green filamentous alga, *Basicladia chelonum* was frequently observed as green patches on the carapace of turtles.

The greatest algal species diversity was encountered among periphyton associated with dead and living surfaces. Desmids (*Closterium,* and *Cosmarium*), diatoms (*Fragilaria, Synedra, Eunotia, Pinnularia, Gomphonema, Nitzschia,* and *Epithemia*) and euglenoids (*Euglena, Trachelomonas, Phacus,* and *Lepocinclis*) were most abundant among the periphyton. The 72 taxa encountered represent all seven algal divisions commonly found in freshwater environments (Table 1).

Table 1. Freshwater algae of the Nags Head Woods ponds. (An incomplete enumeration from collections made during summer, 1987; p = plankton, e = periphyton or epiphyte, fm = floating mat, m = mucilagenous mat.)

	Pond			
Taxon	Frog Pen	Clear	Big	Center
Chlorophyta				
Volvocales				
Pandorina morum (Muell.) Bory	p			
Eudorina elegans Ehr.	p			
Chlorococcales				
Characium sp.			e	
Ankistrodesmus falcatus (Corda) Ralfs			e	
Oocystis sp.				e
Botryococcus braunii Kuetz.	e	p, e		
Scenedesmus sp.			e	
Scenedesmus quadricauda var. *longispina* (Chod.) G. M. Smith	e			
Ulotrichales				
Microspora sp.			fm	
Chaetophorales				
Aphanochaete repens A. Braun			e	e
Oedogoniales				
Bulbochaete sp.			e	
Oedogonium sp.			e	e
Cladophorales				
Basicladia chelonum (Collins) Hoffman				e
Rhizoclonium hierogylphicum (C. A. Ag.) Kuetz.	fm			fm
Zygnematales				
Spirogyra (sp. 1)	fm			
Spirogyra (sp. 2)		fm	fm	
Zygnema sp.	fm			
Closterium sp.	e	e		e
C. kutzingii Breb.	e			
C. leibleinii Kuetz.	e			
C. lineatum Ehr.		e		
C. rostratum Ehr.		e		
C. venus (Keutz.) Breb.		e		
Cosmarium spp.	e			
C. botrytis Menegh.			e	
C. subtumidum Nordst.	e			
Desmidium swartzii C. A. Ag.		fm		
Euastrum sp.			e	
Micrasterias laticeps Nordst.	e			
Staurastrum laeve Ralfs		e		
Hyalotheca dissiliens (Smith) Breb.		fm		
Euglenophyta				
Euglenales				
Euglena acus Ehr.				e
Phacus denisii All. et Lef.	e			
P. nordstedtii Lemm.	e			
P. tortus Lemm. Sku.				p

Table 1. Continued.

	Pond			
Taxon	Frog Pen	Clear	Big	Center
Trachelomonas armata var. *longispina* (Playf.) Defland	e			
T. hispida (Perty) Stein	e			
T. puchella Drezpolski	e			
T. volvocina Ehr.	e	e		
Lepocinclis playfairiana Defland.	e			
Pyrrhophyta				
Dinokontae				
Ceratium hirundinella[1] (O.F. Muell.) Dujardin				
Peridinium sp.	p			
Cryptophyta				
Cryptomonadales				
Cryptomonas sp.	e	e	e	
Chloromonadophyta				
Chloromonadales				
Gonyostomum semen (Ehr.) Diesing		e	e	p
Chrysophyta (Xanthophyceae)				
Tribonematales				
Ophiocytium sp.				e
Tribonema sp.			fm	
Ochromonadales				
Epipyxis			e	
Mallomonas sp.	e			
Dinobryon sertularia Ehr.				p
Synura uvella Ehr.		e		
Chrysophyta (Bacillariophyceae)				
Pennales				
Achnanthes sp.				e
A. hungarica?		e		e
Cocconeis placentula var. *lineata* (Ehr.) V.H.				e
Cymbella minuta?		e		
Epithemia zebra (Ehr.) Kuetz.				e
Eunotia curvata var. *curvata* (Kuetz.) Lagerst.		e		
Eunotia indica var. *indica* Grun.				e
Gomphonema gracile var. *gracile* emend. V.H.		e		
Nitzschia scalaris (Ehr.) W. Sm.		e		
Pinnularia braunii (Grun.) Cleve		e		
P. latevittata var. *domingensis* A. Boyer		e		
P. mesolepta var. *mesolepta* W. Sm.				e
Stauroneis phenicenteron Ehr.				e
Synedra rumpens var. *fragilaroides* Grun.				e
Cyanophyta				
Chroococcales				
Anacystis sp.			e	
Coelosphaerium sp.	e	e		

Table 1. Continued.

Taxon	Pond Frog Pen	 Clear	 Big	 Center
Oscillatoriales				
Oscillatoria sp.		e		
Nostocales				
Nostoc muscorum C. A. Ag.			m	
Anabaena sp.	e		e	
Anabaena azollae Stras.	e			
Rivulariales				
Tolypothrix distorta Kuetz.				fm
Gloeotrichia sp.				e

[1] Present in Nags Head Woods ponds, but not reported from one of the four study ponds.

The present inventory was carried out during only one season (summer) and during an unusually severe drought. It is anticipated that many more taxa will be added to the check list of NHW algae ponds during additional future observations. The current data set is too incomplete to be used to compare individual ponds within the study area in a meaningful manner.

Microalgae undoubtedly play an important role in the carbon and energy flow as well as in nutrient cycling within the ponds, but their significance compared to other primary producers (i.e. macrophytes) remains unknown. Several nitrogen-fixing blue-green algae were present, at various times, in macroscopic amounts. The abundance of *Anabaena azollae* was noted above. Mats of *Tolypothrix distorta* were also frequently entangled among the alligator weed (*Alteranthera philoxeroides*) mats at Center Pond and *Nostoc commune* became ubiquitous as a thin black mucilaginous layer covering exposed sediment at Big Pond, when all of its water evaporated in late summer.

The abundance and diversity of nitrogen fixing blue-green algae suggested that low available nitrogen may have limited plant growth in and around the ponds. Nitrogen-fixing *Nostoc,* on the exposed substrate of Big Pond during August, might have contributed to the luxuriant growth of rooted herbaceous plants which covered that surface four to six weeks later. Many blue-green algae produce copious mucilage in response to drying. Shepard (1987) demonstrated that the mucilage component can act as a reservoir for water, and that the bulk of this water is readily available to support evaporation from the mucilage without imposing extreme osmotic stress on the cells within. Coincidently, the extensive area covered by this alga in ponds in NHW, during periods of drought, may confer a significant measure of protection against desiccation to the underlying sediments and their associated biota.

Several pond diatom taxa (*Pinnularia braunii, Pinnularia latevittata* var. *domingensis, Gomphonema gracile,* and *Eunotia curvata*) have been described as indicators of low pH and low mineral content environments (Patrick and Reimer 1966). These same environmental conditions are also suggested in NHW by the high relative abundance and diversity of desmids. Kim (1967) attributed the taxonomic richness of desmids in the southern coastal plain of North Carolina to the low pH surface waters of the region.

Euglenoids were especially well-represented in the pond sediments and bottom detritus. They occurred even in sediments shaded by a thick layer of floating aquatics and in sediments that smelled strongly of hydrogen sulfide. Since many euglenoids are capable of at least limited heterotrophic uptake, they may be able to utilize organic nutrients released during decomposition of detritus in pond sediments, where photosynthesis is limited by dense shading.

Many of the pond algae apparently survived drought conditions in a vegetative state while embedded in the moist peat that covered the exposed pond sediments. Samples of peat were recovered from beneath a dense sedge mat that occupied the bottom of Big Pond in autumn, 1987. The algae inhabiting these sediment samples exhibited a high degree of taxonomic similarity to algae recovered from other microhabitats prior to complete drying of the pond. It is likely that algae residing in these sediments will rapidly reoccupy their former microhabitats when water levels rise in the ponds.

The NHW freshwater ponds support a diverse microalgal assemblage. Although these algae are physically isolated from mainland freshwater environments, there are probably sufficient exchanges of individual algae, carried by migrating animals or blown on the wind, to maintain genetic continuity within populations and to prevent local extirpation of a species.

The algal flora is dominated by motile unicells. Algae exhibiting this morphology are typically capable of rapid asexual reproduction when growth conditions are optimal. They usually produce cysts or resistant sexual spores when stressed. The microalgae of NHW ponds seem to be well-adapted to occasional episodes of severe drought.

Acknowledgments

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VASCULAR VEGETATION OF SELECTED NAGS HEAD WOODS PONDS

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ABSTRACT

Four freshwater ponds in Nags Head Woods, North Carolina were surveyed to note their vascular plant species composition. The survey was conducted to establish baseline data, during the low water period of a recent drought, to use in tracking changes in the ponds as water levels return to "normal" levels. Two relatively small ponds, and two larger ponds were selected for monitoring. One of the larger ponds, had been dredged and differed from the other three in many shoreline characteristics and vegetation. Vegetation composition was similar among the other three ponds, although species diversity varied directly with pond size. Invading saplings of wetland tree species occurred in all of the ponds and may have a lasting effect on pond vegetation composition, if these become established. Long term effects of exotic species occurring in the ponds was also considered.

INTRODUCTION

Vascular vegetation is an integral part of pond ecosystems. Rooted plants bridge the transition between the aquatic and terrestrial components of a pond, providing cover and food for numerous aquatic and amphibious animals. Vascular vegetation, occurring in ponds of The Nags Head Woods Ecological Preserve, North Carolina, varies from free floating and submerged aquatic species to emergent herbaceous and woody species. Composition of a pond's vascular vegetation is related largely to shoreline gradient. Ponds with gradually sloped shorelines generally support a greater diversity of plants than do ponds with steep sloped shorelines. Water chemistry may also be an important factor influencing distribution patterns of the aquatic species in the ponds, although this has not been well studied within Nags Head Woods (NHW) ponds.

The recent drought of 1986–87 significantly reduced water levels throughout the NHW pond systems. Consequently, vascular plant cover increased in many of the ponds. The purpose of this study was to record the vascular plant species composition and zonation of four ponds, during the low water period of September 1987. Plants included in this survey were: terrestrial species directly adjacent to the high water mark, emergent wetland species of the shoreline fringe marshes, and floating and submerged species. The survey was limited to vascular vegetation and did not include algae, bryophytes, mosses or liverworts.

METHODS

A survey of vascular plant species composition and zonation was made of four ponds selected by The Nature Conservancy: Clear Pond, Frog Pen Pond (hereafter referred to as Frog Pond), Center Pond, and Pond #13 (hereafter referred to as Big Pond) (Fig. 1). Field work was conducted from 31 August to 5 September 1987. Sample points were selected around the periphery of each pond, roughly 15–25 m apart. At each sample point, a transect was made from the high water mark to the zone of open water. Each transect passed through two or more zones of distinct vegetation association. Vascular vegetation was identified by species and listed in order of dominance within each zone along a given transect. An estimate of the width (in meters) of each zone was noted on base maps. This information was used to create maps of vegetation zonation in each pond. Aquatic and wetland species were

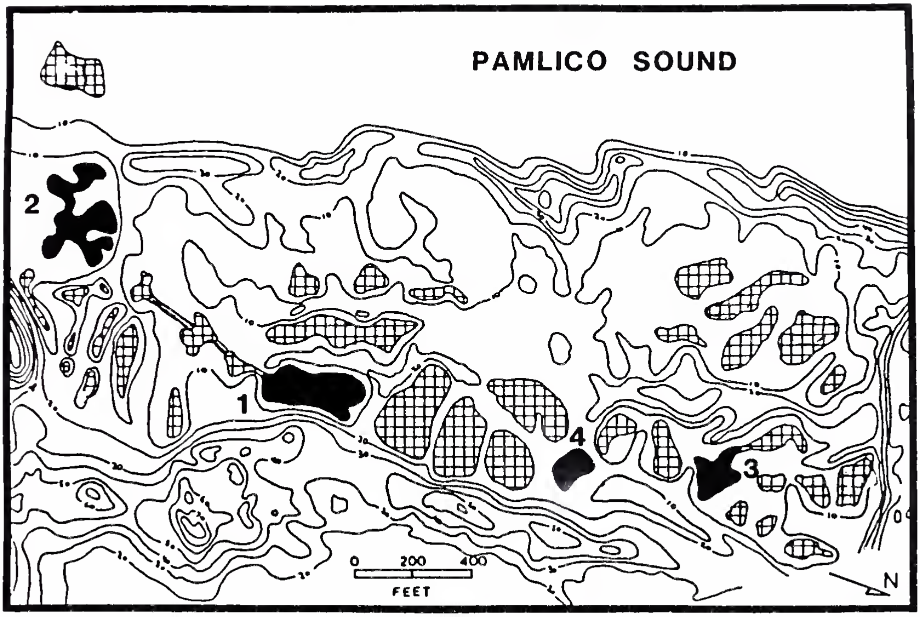

Fig. 1. Ponds surveyed for vascular vegetation in Nags Head Woods (after Otte *et al.* 1985): 1. Big Pond; 2. Center Pond; 3. Frog Pond; 4. Clear Pond.

identified, collected, preserved, and donated to the herbarium at Cape Hatteras National Seashore Headquarters in Manteo, North Carolina. Species listed which were not collected are noted in the following section. Taxonomic nomenclature followed Radford *et al.* (1968).

RESULTS

A total of 44 vascular plant species associated with the four ponds were identified (Table 1). Although there were a number of species shared between all four ponds, each pond contained species not found in the others. Total number of plant species varied by pond and pond size. Larger ponds, such as Center and Big ponds, possessed 26 and 35 species, respectively. Frog and Clear ponds harbored 18 and 13 species, respectively.

Frog and Big ponds possessed gradually sloping shorelines, and well established fringe wetlands. Clear Pond shores and adjacent upland slopes were steep and lacked an extensive fringe marsh. Center Pond's shoreline dropped off abruptly, an artifact of dredging. The fringe wetland of Center Pond was mainly composed of species which tolerate inundation.

Little difference was noted in vegetation species composition occupying the periphery of the ponds (Table 2). The canopy was generally dominated by wetland species, i.e. *Liquidambar styraciflua, Nyssa sylvatica, Acer rubrum,* and *Salix caroliniana. Myrica cerifera* and *Salix* dominated the shrubs located around the ponds. Ferns, primarily *Thelypteris palustris,* were found scattered along the high water mark at each pond. *Osmunda cinnamomea* found only at Clear Pond, was not collected as it occurred sparingly and had only recently germinated. Seedlings of peripheral tree species grew in all of the ponds, except Frog Pond, in areas of sunlit bare soil recently exposed by the receding water levels. Frog Pond had a dense peripheral herbaceous and shrub fringe wetland around the periphery where

Table 1. Aquatic and wetland species identified in four ponds. (Asterisk indicates exotic species.)

Species and vegetation type	Ponds			
	Big	Center	Frog	Clear
Floating and submerged aquatics				
Spirodela polyrrihza	X	X	X	X
Lemna spp.	X	X	X	X
Wolffia columbiana	X		X	X
Azolla caroliniana		X	X	
Limnobium spongia	X		X	X
Utricularia subulata	X		X	
Utricularia gibba		X		
Emergent aquatic graminoids				
Leersia oryzoides	X	X	X	X
Eleochris baldwinii	X	X	X	X
Sacciolepsis striata	X	X	X	
Cyperus strigosus	X		X	
Carex comosa	X		X	
Carex alata		X		
Carex crinita		X		
Dulichium arundinaceum	X			
Juncus canadensis	X			
Fuirena pumila	X			
*Phragmites communis**	X			
Unknown grasses	X		X	X
Emergent aquatic herbs				
Hydrocotyle ranunculoides	X	X	X	X
Bidens frondosa	X	X	X	X
Hypericum walterii	X	X	X	X
Lycopus rubellus	X	X	X	X
Ludwigia palustris	X	X		X
Boehmeria cylindrica	X	X	X	
Proserpinica palustris	X	X		
Hydrocotyle umbelata	X	X		
Saururus cernuus	X	X		
Galium tinctorium	X	X		
Polygonum hydropiper	X	X		
Polygonum hydropiperoides		X		
Polygonum punctatum	X		X	
Polygonum pennsylvanicum	X			
Sagittaria latifolia	X			
Sparganium americanum	X			
Hypericum mutillum	X			
Hypericum virginicum	X			
*Alternanthera philoxeroides**		X		
Pluchea sp.		X		
Centella asiatica		X		
Wetland shrubs				
Decodon verticilatus	X		X	X
Rosa palustris	X	X		
Cephalanthus occidentalis		X		
Total number of species identified	35	26	18	13
Size of pond (hectares)	0.85	0.69	0.28	0.20

Table 2. Species identified along the periphery of the ponds. (Asterisk indicates exotic species.)

	Ponds			
Species and vegetation type	Big	Center	Frog	Clear
Trees				
Nyssa sylvatica	X	X	X	X
Acer rubrum	X	X	X	X
Persea borbonia	X	X	X	X
Salix caroliniana	X	X	X	X
Liquidambar styraciflua	X	X	X	X
Pinus taeda	X	X	X	X
Fagus grandifolia				X
Carpinus caroliniana				X
Ilex opaca	X			
Shrubs and vines				
Myrica cerifera	X	X	X	X
Vitis rotundifolia	X	X	X	X
Parthenocissus quinquefolia		X		X
*Lespedeza bicolor**		X		
Hypericum hypericoides		X		
Vaccinium corymbossum				X
Campsis radicans		X		
Ferns				
Thelypteris palustris	X	X	X	X
Osmunda regalis	X	X		X
Woodwardia virginica				X
Invading peripheral species				
Tree and vine seedlings				
Acer rubrum		X		
Liquidambar styraciflua	X			
Pinus taeda	X			
Persea borbonia	X	X		X
Nyssa sylvatica	X			X
Salix caroliniana	X			
Myrica cerifera		X		
Vistis rotundifolia	X			X
Campsis radicans		X		
Herbs				
Eupatorium capillifolium	X	X	X	
Solidago rugosa		X		
Mikania scandens	X	X		

little bare soil was evident. Opportunistic upland herbs (i.e. *Eupatorium capillifolium* and *Solidago rugosa*) grew within the recently exposed shore of all the ponds except Clear Pond, although most of the growth along the exposed pond shores was composed of wetland species.

Three exotic species occupied the periphery of two ponds. Shoreline vegetation along Center Pond was dominated by *Alternanthera philoxeroides*, a South American aquatic pond weed. An ornamental shrub, *Lespedeza bicolor* was noted overhanging the water's edge in one of the small embayments of Clear Pond. *Phragmites communis* was noted along the marsh edge of a stand of trees which bisects Big Pond.

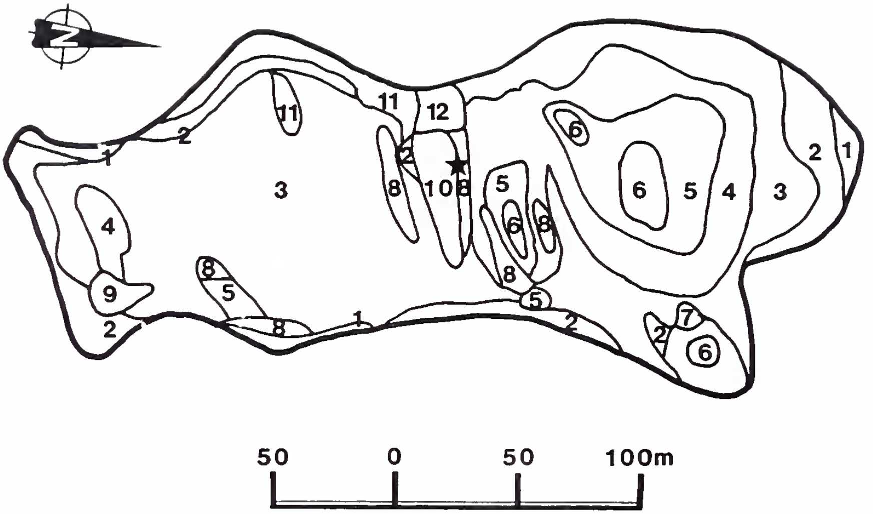

Fig. 2. Distribution of vegetation in Big Pond, September 1987; Vegetation Zones and dominant species: 1. *Saururus/Boehmeria/Decodon*; 2. *Sparganium*; 3. *Polygonum/Eleocharis/Leersia*; 4. *Eleocharis/Hydrocotyle*; 5. *Hydrocotyle/Eleocharis/Utricularia*; 6. *Spirodela/Lemna/Hydrocotyle*; 7. *Limnobium*; 8. *Sagittaria*; 9. *Cyperus*; 10. Trees; 11. *Decodon*; 12. *Dulichium/Proserpinica/Decodon*; *Phragmites*.

Big Pond—The most varied vascular plant zonation was found in Big Pond (Fig. 2). *Persea borbonia* was the most common shore species. Other trees growing along the shore included *Myrica, Liquidambar, Salix, Nyssa,* and *Ilex opaca* in order of dominance. *Saururus cernuus, Sparganium americanum,* and *Boehmeria cylindrica* dominated herbaceous growths along the shore edge. *Thelypteris* occupied the driest parts of the shoreline, and *Polygonum pennsylvanicum* dominated the wettest shoreline areas. Seedlings of *Nyssa* and *Persea,* among other species (Table 2), were noted in several locations along its western shore. *Pinus taeda* and *Salix* seedlings as well as several stands of *Phragmites* grew along the shore of a small island of trees in the center of the pond. *Decodon* frequently occurred in bands along the shore and in small patches within the marshy portions of the pond. A shaded area west of the central island of trees harbored a unique marsh association dominated by *Dulichium arundinaceum* and *Prosepinica palustris.* The center of the pond on either side of the island was a broad zone of quaking bog mat which was dominated by *Polygonum punctatum, Hydrocotyle ranunculoides,* and hummocks of various graminoids. These included: *Eleocharis baldwinii, Leersia oryzoides, Sagittaria latifolia, Cyperus strigosus,* and two unidentified tall grasses. *Eleocharis* stands were the most robust noted, occurring in very dense patches, 30 cm or more in height. Bladderworts (*Utricularia* spp.) and *Limnobium spongia* were also common on this mat. Several small areas of open wet mud were almost completely covered with pondweeds: *Lemna* ssp., *Spirodela polyrrhiza, Azolla caroliniana,* and *Hydrocotyle ranunculoides.* One of these small patches, in the northeast corner of the pond, contained small stranded fish which were flipping about in the mud. No open water was noted in this pond at the time of the survey.

Center Pond—*Myrica* dominated the upland to shore transition area of Center Pond, and shaded many areas of open water around the periphery (Fig. 3). Other

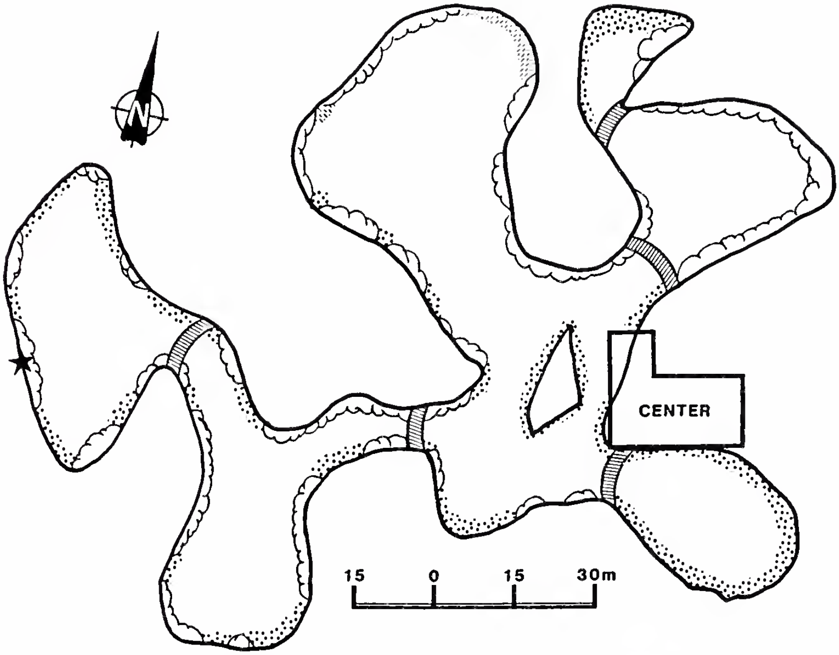

Fig. 3. Distribution of vegetation in Center Pond, September 1987: ▨ Bridges; 〰 Tree/shrub overhang; ⁘ *Alternanthera*; ▒ Graminoid fringe marsh; ★ *Lespedeza*.

tree and shrub species encircling Center Pond included *Pinus, Salix, Cephalanthus occidentalis, Liquidambar, Persea,* and *Acer.* Aquatic and wetland vegetation in Center Pond was dominated by an exotic pondweed, *Alternanthera philixeroides.* Where *Myrica* and *Salix* branches overshadowed the water, *Alternanthera* did not grow well. The shoreline gradient of this dredged pond was generally abrupt and vegetated by species which tolerate inundation. *Hydrocotyle ranunculoides* and *Utricularia gibba* were common among the *Alternanthera* (Table 1). Other marsh species common to the other three ponds occurred in some of the western embayments of Center Pond, where the shoreline slope was less steep. Such areas were dominated by *Leersia, Eleocharis,* and *Sacciolepsis striata.* Seedlings of tree and vine species, especially *Acer,* were common on the exposed bank areas (Table 2).

Frog Pond—Trees around the periphery of Frog Pond were codominated by *Nyssa, Pinus,* and *Liquidambar,* and included *Acer, Persea,* and *Salix* (Table 2). Vegetation patterns in Frog Pond were similar to, but less diverse than those encountered in the larger Big Pond (Fig. 4). The shoreline was densely vegetated by wetland species, and no exotic species or invading upland seedlings or herbaceous species were noted. *Decodon verticilatus* occurred in several dense patches, the largest of which was at the easternmost tip of the pond. A quaking bog mat dominated by *Eleocharis* and *Hydrocotyle ranunculoides* covered the majority of the pond surface. *Eleocharis* stands were much less robust than those found in Big Pond, and formed a sparse mat of short (10–20 cm) culms. *Leersia, Polygonum hydropiperoides,* and *Utricularia subulata* also occurred frequently throughout the bog mat. The center of the pond was a more aqueous mud which was sparsely covered by floating vegetation, although no open water was evident. This area

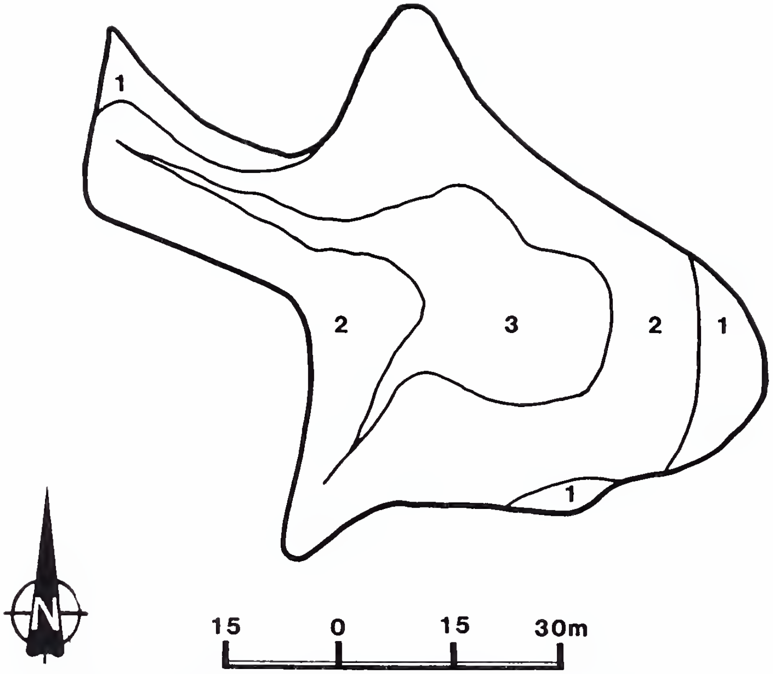

Fig. 4. Distribution of vegetation in Frog Pond, September 1987; Vegetation zones and dominant species: 1. *Decodon*; 2. *Eleocharis/Hydrocotyle/Leersia/Utricularia*; 3. *Spirodela/Azolla/Lemna/Wolffia*.

(Fig. 4, zone 3) was dominated by *Spirodela polyrrhiza, Azolla caroliniana, Wolffia columbiana,* and *Lemna* ssp., in descending order of dominance.

Clear Pond—The slope of the adjacent wooded dunes and the shoreline of Clear Pond were steep. Upland species such as *Fagus grandifolia* and *Carpinus caroliniana,* which did not occur along the shore of the other three ponds (Table 2), were found growing within a foot of the high water mark around Clear Pond. Clear Pond was the smallest pond studied (Fig. 5), and contained the fewest number of vascular plant species (Table 1). Its northern shore, a sparsely vegetated mud flat, was drier than the southern shore. Vegetation on the mud flat was dominated by *Leersia,* with scattered patches of *Eleocharis* and *Hydrocotyle ranunculoides. Utricularia* ssp. were not found, although similar mud flat/bog mats in Frog and Big ponds contained at least one species of bladderworts. *Decodon* occurred within an open mud flat as a 1–2 m wide patch in the southwest corner of the pond. The center area of the pond, which was about 30 by 20 m in size, contained open water and supported a sparse growth of *Spirodela* and *Limnobium.*

DISCUSSION

Species composition and vegetation zonation in Big, Frog, and Clear ponds shared many similarities (Table 1). Center Pond differed from the other ponds in zonation and species composition because of its steep shoreline, an artifact of dredging.

Water levels in all four ponds were greatly reduced, as a result of a severe drought occurring in 1986–87. This produced a large amount of exposed shoreline:

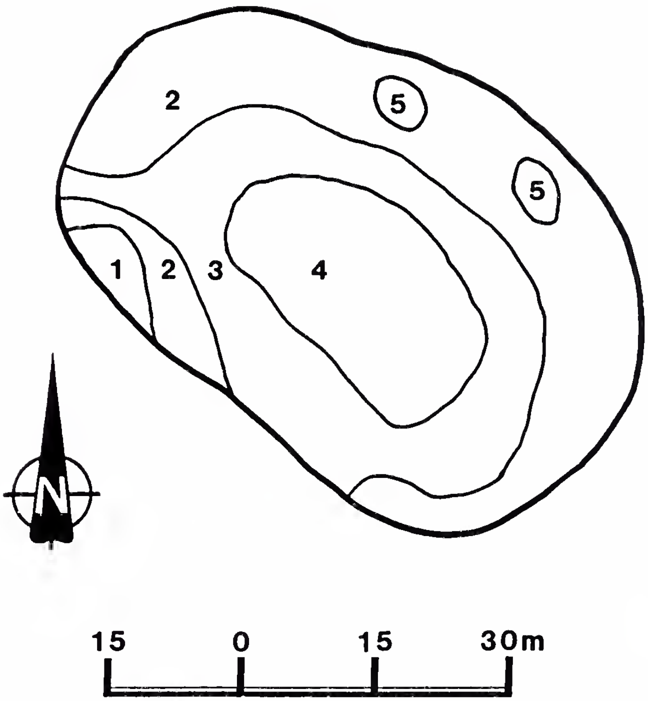

Fig. 5. Distribution of vegetation in Clear Pond, September 1987: Vegetation zones and dominant species: 1. *Decodon*; 2. Mudflat—*Leersia*; 3. Mudflat—sparce *Leersia* and *Eleocharis*; 4. Open water—*Spirodela*; 5. *Eleocharis*.

approximately 1 m around Center Pond, 1–2 m around Frog Pond, approximately 2–3 m around Clear Pond, and approximately 5 m around Big Pond. The exposed shoreline substrates of all four ponds was composed of a layer of organic matter of varying depths overlaying sand. Where the exposed shore was covered by overhanging shrubs, very little new growth was observed. However, sunlit, exposed shorelines supported numerous wetland species as well as seedlings of invading tree species, and opportunistic upland herbs such as *Eupatorium capillifolium*. Ponds which had well developed wetlands prior to the drought (i.e. Big and Frog Ponds) had the densest growths of wetland species in the newly exposed areas of the ponds. Wetland species growing in open areas of exposed shoreline were codominated by *Boehmeria cylindrica* and *Saururus cernuus* in shaded areas, and by *Leersia, Eleocharis, Polygonum* ssp., and *Hydrocotyle ranunculoides* in sunlit areas. Ferns, primarily *Thelypteris palustris* occurred sparsely in areas of exposed, shaded shoreline near the high water mark. Much of the species diversity common to Big and Center ponds occurred in this zone of recently exposed shoreline.

The shoreline of Big Pond was structurally diverse with mixed areas of shaded and open shoreline. Several wetland species identified only at Big Pond were associated with the shoreline around the small island of trees which bisects the pond. These included: *Hypericum mutillum, H. virginicum, Dulichium arundinaceum, Juncus canadensis,* and *Phragmites communis.* Other species identified at Big Pond which were not found at the other ponds included *Sparganium americanum, Sagittaria latifolia,* and *Fuirena pumila.* These species are relatively common freshwater hydrophytes, and most were identified prior to the drought by Otte *et al.* (1985). Large colonies of *Sparganium* and *Sagittaria* were established in Big Pond before the drought, as were small stands of *Phragmites.* Big Pond was the furthest along in its natural succession from pond to wetland. Although the most recent drought may have accelerated the rate of this succession by encouraging further establishment of wetland species, the greater species diversity of Big Pond, relative to the other ponds, was probably a function of factors that existed prior to the drought.

A quaking bog mat was located interior to the exposed shoreline in Big, Frog, and Clear ponds. The bog mat was best developed in Big Pond and least developed in Clear Pond. No such mat was present in Center Pond. This quaking bog mat was composed of organic matter held together by a network of *Eleocharis, Leersia, Hydrocotyle ranunculoides,* and possibly one or more species of algae. The mat was about 15–25 cm thick and was suspended over a more aqueous substrate of about 0.25–1.0 m. Patches of *Decodon verticillatus, Bidens frondosa,* and *Cyperus strigosus* occurred in the mat associated with the drier areas. *Polygonum punctatum* dominated large stretches of the bog mat in Big Pond. Dense stands of *Eleocharis* and *Leersia* were the dominant bog mat species of Frog and Clear Ponds, although neither species was as well established as in Big Pond. Stranded patches of floating aquatics (i.e. *Spirodela, Lemna, Wolffia,* and *Azolla*) were common throughout the bog mat.

Bladderworts (*Utricularia*) of a yellow-blooming emergent species were found in the wetter areas of Frog and Big pond bog mats; none were found in Clear Pond. A specimen preserved from Frog Pond was positively identified as *U. subulata,* however other species may also have occurred. The Master Species List compiled by the Nags Head Woods Preserve (1985) lists *U. biflora,* and *U. inflata.* The only other bladderwort identified was a submerged species, *U. gibba* found among the submerged roots of *Alternanthera* throughout Center Pond. Bladderworts identified by Otte *et al.* (1985) in Big, Frog, and Clear ponds, were represented by several species.

The deepest areas of the ponds were open waters covered by varying amounts of floating aquatics. Floating aquatic vegetation was dominated by *Spirodella polyrrhiza,* and also included *Azolla caroliniana, Lemna* ssp., *Wolffia columbiana,* and *Limnobium spongia.* Center Pond had the largest area of open water, however, it was only sparsely vegetated with floating aquatics. Clear Pond also had a large area of open water that had only a few floating aquatics. The open water of Frog Pond was densely covered with floating aquatics. Four densely covered areas of mud about 1–3 m in diameter occurred on Big Pond. "Waters" of Frog and Big ponds were thick with suspended particulates, and were more aptly labeled colloidal muds.

Species composition and diversity differences among the four ponds appeared to be strongly related to size and depth gradient. Big Pond was the largest, (0.85 ha) and most shallow. Big Pond graded from swamp species of trees, to open wetland, and very limited unvegetated mud. The shallow substrate gradient and structurally diverse shoreline provided a greater variety of habitats to support a larger number of species than did that of the other three ponds. Although Center Pond was large (0.69 ha), the dredged shoreline sloped too steeply to support many of the marsh species found in Big Pond. However, where the shoreline was less steep, in some of the embayments, a fringe marsh developed similar to that found along the shorelines of the other three ponds. Apparently, *Alternanthera* dominated Center Pond because it is adapted to this artificial shoreline better than the native species presently growing there. Species diversity of the smaller Frog and Clear ponds was in turn smaller (Table 1). The shoreline of Frog Pond was irregular (Fig. 4) and had a shallower slope. This pond supported a fringe marsh prior to the drought (Otte *et al.* 1985). The fringe marsh vegetation in Frog Pond was much denser than that found in Clear Pond; established wetland species apparently expanded into the newly exposed shore. Clear Pond on the other hand, historically has been devoid of rooted vegetation, from which its name was derived (Henrietta List, pers. commun.). Wetland species growing around Clear Pond were newly established, and sparsely distributed on the exposed mud flat.

One of the most notable changes in the ponds, since the drought, was the invasion of woody seedlings along their exposed shorelines. Ultimate effects of this invasion will depend upon the duration of shoreline exposure. Some of the saplings, such as those of *Persea* and *Pinus* are temporary inhabitants and will not survive inundation once water levels return to "normal" levels. Established saplings of *Salix*, *Nyssa*, and *Acer* however, can tolerate inundation and may over time influence the shoreline vegetation patterns. Shading limits the extent of many herbaceous marsh species, especially the graminoids which inhabit fringes of a pond. These species have high light requirements and depend on a seasonal fluctuation of water level, a condition not tolerated by saplings of most woody species. If woody species become abundant, the herbaceous fringe species will decline, changing the character of aquatic habitats associated with the ponds. This may be a part of a larger successional cycle. The lower water levels of 1987 exposed many old buttressed stumps in the center of Big, Frog, and Clear ponds. These may be remnants of trees established during another such drought, or during the evolution of the ponds and the woods.

The differences in species composition noted between the ponds, especially those relating to total numbers of species found are only tentative. Although most of the pond species were visible when the ponds were sampled in September, many spring and summer ephemerals may have been completely missed. Species list given by Otte *et al.* (1985) and the Master Species List of Nags Head Woods (1985) contain several such ephemerals. More extensive seasonally sampling will resolve these concerns.

MANAGEMENT RECOMMENDATIONS

Presence of exotic species is a major concern, especially during a period of extended stress, such as a drought. Of the three exotic species identified in the NHW ponds, *Phragmites* probably poses the greatest threat. This species, once established, expands rapidly by rhizomes during periods of low water, and forms dense stands. These stands do not intermix with other marsh species, but create a monoculture which excludes the more diverse native species and provides few wildlife habitat benefits. Once established, *Phragmites* is difficult to remove and continues to expand throughout a wetland. The tall reeds produce heavy amounts of organic matter which build hummocks of drier organic soils providing for further expansion of new rhizomes. For this reason it is an economically favored plant in the Netherlands, where it is used to build soil on newly reclaimed diked lands (Toorn and Mook 1982). However, it does not compete well as a seedling with native marsh species in regularly inundated areas. At present it is not well developed in Big Pond and should be removed while the stands are small. The pond survey conducted by Otte *et al.* (1985) identified *Phragmites* in at least one other pond. The entire pond system of NHW should be reviewed for the presence of *Phragmites*, and if found it should be removed.

The two exotic species identified in Center Pond are of less concern. *Alternanthera* probably dominated the fringe species of Center Pond because it is better adapted to the unnatural shoreline than were the native species. Several native species occurred intermingled with the *Alternanthera*. These included *Utricularia gibba*, *Hydrocotyle ranunculoides*, and *Polygonum hydropiper*. Any attempt to remove the *Alternanthera* would also remove these native species. The seed bank of the *Alternanthera* is at least as well established as that of the native species. Therefore, it is probable that plants replacing those removed would be of similar composition, even if an attempt of seeding other species was made. Although it is doubtful that *Alternanthera* can be completely removed from Center Pond, dominance patterns might be shifted towards native species. Plantings of native species such as *Nymphaea odorata* or *Sagittaria latifolia* might be successful and may compete with the *Alternanthera*. Where the native aquatics become established, they will shade out *Alternanthera* which has high light requirements. This exotic appears to be limited to Center Pond and has not spread to adjacent ponds. Dominance of this weed in Center Pond is likely an artifact of the altered shoreline and will continue to dominate where that condition exists.

The Japanese flowering shrub, *Lespedeza bicolor* which occurred along the shore of one of the embayments of Center Pond, does not appear to pose any significant threat to the native vegetation of NHW. Where it was found, it occurred in a discrete location with no indication of spreading. This is an aesthetically pleasing shrub, as the fruits of this shrub are enjoyed by many species of small mammals and birds. Likewise, the flowers were heavily attended by insect pollinators, especially the large swallowtail butterflies common to NHW. The shrub should be checked periodically to insure that it is not spreading and crowding out native species.

A seasonal pond follow-up survey designed to sample ephemeral species would establish additional baseline data for use during the long-term observations of pond recovery. Invasion of woody species should also be monitored, possibly by photo record as a part of the Pond Watch surveys.

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BENTHIC MACROINVERTEBRATES OF SELECTED PONDS IN THE NAGS HEAD WOODS ECOLOGICAL PRESERVE

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ABSTRACT

Qualitative sampling of the benthic macroinvertebrate fauna of four ponds in the Nags Head Woods Ecological Preserve was conducted in April and May 1987. The overall faunal composition, as well as the distribution of taxa within ponds, was primarily affected by low oxygen levels and the presence of dense beds of aquatic vegetation. A total of 70 taxa were collected. Diptera, coleoptera, and odonata had highest taxa richness, with 18, 15, and 11 taxa respectively. Amphipods, isopods, and *Sphaerium* clams were most abundant. Water chemistry data, taken at the time of sampling in May, are also provided.

INTRODUCTION

Benthic macroinvertebrates live within or on top of the bottom substrates (soft sediments, rocks, logs, and attached vegetation) of rivers, streams, lakes, and ponds. Benthic communities, in lentic systems, are often composed primarily of aquatic diptera, especially chironomids and oligochaetes (Benson *et al.* 1980; Cooper 1981; Cowell and Vodopich 1981). Crustacea, molluscs, and other aquatic insects are also important constituents of the benthic fauna (Moore 1980; Wiederholm 1980). Composition of any benthic community is dependent on many factors, including substrate type, current velocity, water chemistry (presence or absence of pollutants, dissolved oxygen levels, nutrient levels are examples), and presence of vertebrates (especially fishes) which may forage on the benthos (Post and Cucin 1984).

A benthic community of a pond is often less diverse than that of a stream or river. This reduction in taxa richness is caused by the lack of flow and by lower dissolved oxygen levels that naturally eliminate many of the intolerant insect species (Hynes 1972). Bottom sediments of small ponds (like those at Nags Head Woods) are often lacking in oxygen because of decomposing organic matter. Therefore, much of the invertebrate community may be found associated with rooted aquatic plants that provide substrate above the anoxic region of the pond.

METHODS

Preliminary benthic samples were taken from Clear Pond, Frog Pen Pond, and Pond #13 in April 1987. More extensive qualitative samples were taken from these three ponds and Center Pond in May 1987. Emphasis was placed on sampling all habitats present, rather than taking a set number of samples. Sampling effort at each pond was about equal.

The primary collection technique for macroinvertebrates involved using sweep nets to collect organisms in the littoral zone, or within beds of rooted aquatic vegetation, after the substrate had been vigorously disturbed to dislodge the organisms. Petite ponar grab samples (0.09 m^2) of bottom sediments were also taken to sample organisms present within the bottom substrate. Finally, visual inspections were made of logs, sticks, and aquatic vegetation for tightly adhering organisms that may have been missed during the sweep samples.

Table 1. Benthic macroinvertebrates present in selected Nags Head Woods ponds, April and May 1987 (X = present).

	Pond			
Taxa	Clear	Frog Pen	Center	#13
Turbellaria				
Planeriidae				
Dugesia tigrina			X	X
Mollusca				
Gastropoda				
Lymnaeidae				
Pseudosuccinea columella				X
Physidae				
Physella	X		X	X
Planorbidae				
Menetus dilatus		X	X	X
Pelecypoda				
Sphaeriidae				
Sphaerium		X	X	X
Hirudinea				
Glossiphoniidae				
Helobdella fusca			X	
Helobdella triserialis			X	
Placobdella papillifera				X
Placobdella parasitica	X			
Erpobdellidae				
Erpobdella/Mooreobdella		X		X
Oligochaeta				
Naididae				
Dero flabelliger		X		
Dero obtusa	X		X	X
Lumbriculidae	X	X	X	X
Tubificidae		X		
Limnodrilus hoffmeisteri	X			
Crustacea				
Amphipoda				
Gammaridae				
Crangonyx	X			X
Talitridae				
Hyallela azteca		X	X	X
Isopoda				
Asellidae				
Asellus	X	X	X	X
Hydracarina	X			X
Ephemeroptera				
Caenidae				
Caenis		X	X	
Odonata				
Zygoptera				
Lestidae				
Lestes disjunctus australis	X	X		X
Coenagrionidae				
Enallagma	X			
Ischnura	X		X	

Table 1. Continued.

	Pond			
Taxa	Clear	Frog Pen	Center	#13
Anisoptera				
Aeshnidae				
Anax junius	X			
Libellulidae				
Erythemis simplicicollis	X	X	X	X
Erythrodiplax	X			
Ladona deplanata	X			
Libellula	X		X	
Pachydiplax longipennis	X	X	X	X
Perithemis			X	
Tramea lacerata	X			
Coleoptera				
Chrysomelidae				
Pyrrhalta nymphaea	X			
Curculionidae				
Bagous	X			X
Dytiscidae				
Agabus	X			X
Coptotomus	X			
Cybister fimbriolatus	X			
Hydrovatus pustulatus	X	X	X	X
Graphoderus liberus	X			
Thermonectes basillaris basillaris	X			X
Hydroporus	X		X	X
Gyrinidae				
Dineutes assimilis	X		X	
Haliplidae				
Peltodytes sexmaculatus	X	X	X	X
Hydrophilidae				
Berosus				X
Tropisternus glaber	X	X	X	X
Noteridae				
Hydrocanthus oblongus	X			X
Suphisellus		X		
Megaloptera				
Corydalidae				
Chauliodes rastricornis	X			
Diptera				
Chaoboridae				
Chaoborus punctipennis	X	X	X	
Culicidae				
Culex				X
Ceratopogonidae				
Alluaudomyia	X	X		X
Palpomyia group				X
Chironomidae				
Ablabesmyia peleensis	X	X		X
Chironomus			X	
Guttipelopia			X	
Dicrotendipes			X	
Einfeldia gr A			X	

Table 1. Continued.

Taxa	Pond			
	Clear	Frog Pen	Center	#13
Endochironomus			X	
Glyptotendipes			X	
Kiefferulus dux	X	X		X
Larsia				X
Polypedilum illinoense		X		X
Procladius	X			
Sciomyzidae			X	
Stratiomyidae				
Odontomyia				X
Tipulidae				
Hexatoma	X			
Heteroptera		X		
Belostomatidae				
Belostoma	X	X	X	X
Corixidae				
UID nymphs				X
Naucoridae				
Pelocoris	X	X		X
Notonectidae				
Notonectus	X	X		X

All samples were sorted in the field and preserved in 95% ethyl alcohol. A list of taxa collected at each pond was compiled (Table 1). This list must be considered preliminary, as it is based on limited qualitative sampling.

Temperature, dissolved oxygen, pH, and conductivity were measured in May using a Hydrolab 4000 series meter from surface to bottom at several stations along a transect across each pond (Table 2). Water chemistry samples were also taken from surface waters in the center of each pond. These were analyzed for BOD, fecal coliforms, chlorophyll-a, and nutrients, by the North Carolina Division of Environmental Management Central Laboratory (Table 3).

RESULTS

A total of 70 taxa of benthic macroinvertebrates were collected from all four ponds sampled (Table 1). Diptera, coleoptera, and odonata were the most abundant groups with 18, 15, and 11 taxa respectively. Although some differences were noted in the composition of the benthic community in each pond, the overall faunal composition was similar in the four ponds sampled. Clear Pond had the greatest taxa richness with 41 taxa collected; Pond #13 was second with 38 taxa present. Center Pond had 30 taxa, while Frog Pen Pond had 25 taxa (Table 4).

Physical and water chemistry results are presented in Tables 2 and 3. Water temperatures range from 24.1 C in Pond #13 (Station 3, surface) to 13.6 C at 2.5 m depth in Center Pond.

Dissolved oxygen levels were generally low, with only three values above 5 mg/l (Table 2). These latter values were noted in beds of dense vegetation where photosynthetic activity would be producing oxygen at the time measurements were taken. Clear Pond demonstrated this effect, where DO levels ranged from 1.4 to 1.8 mg/l except in the rooted vegetation where a level of 3.5 mg/l was measured.

Table 2. Physical parameters for selected Nags Head Woods ponds: temperature, DO, conductivity, and pH, May 1987.

Station	Depth (m)	Time	T (°C)	DO (mg/l)	pH	Cond (μmhos)
Center Pond						
1	Surface	10:21	21.0	4.4	6.2	220
1	0.8		20.8	3.8	6.2	221
2	Surface	10:26	20.7	6.4	6.3	217
2	0.4		20.4	3.7	6.3	218
3	Surface	10:45	21.2	4.1	6.2	216
3	1.0		20.8	3.2	6.3	216
4	Surface	10:51	21.9	4.3	6.2	218
4	0.5		20.8	3.0	6.1	219
4	1.5		16.9	2.0	6.0	247
5	Surface	11:05	22.7	5.1	6.1	217
5	0.5		20.6	2.2	6.1	221
5	1.0		14.3	2.0	6.0	268
5	1.5		13.7	2.0	6.0	278
5	2.5		13.6	2.0	6.0	288
Pond #13						
1	Surface	11:41	23.1	1.9	6.0	181
2	Surface	11:46	21.8	3.4	6.0	184
3	Surface	11:50	22.8	1.8	6.1	192
3	0.3		20.7	2.0	6.1	196
4	Surface	12:00	26.4	6.0	6.1	136
Clear Pond						
1	Surface	12:24	22.7	1.4	5.5	194
1	0.5		20.4	1.6	5.6	203
2	Surface	12:30	23.5	1.6	5.3	200
2	0.5		19.9	1.5	5.5	213
3	Surface	12:35	24.1	1.6	5.3	195
3	0.5		20.4	1.7	5.4	209
4	Surface	12:42	26.1	1.7	5.2	195
4	0.5		20.3	1.8	5.3	206
5	0.2	12:45	28.9	3.5	5.3	196
Frog Pen Pond						
1	0.3	13:10	20.7	2.2	6.2	226
2	Surface	13:20	21.7	2.0	6.0	223
2	1.0		20.3	2.1	6.1	238
3	Surface	13:26	23.7	1.7	6.1	219
3	1.0		20.1	2.0	6.0	253
4	Surface	13:32	23.9	1.5	5.9	214
4	1.0		20.1	1.7	5.9	261
5	Surface	13:39	23.3	2.9	6.0	237
5	1.0		20.4	2.1	5.9	323

pH levels were fairly uniform throughout all four ponds, ranging from 5.2 to 6.3 standard units (Table 2). Clear Pond, however, had lower pH measurements (5.2–5.6) than the other ponds (5.9–6.3).

Conductivity values ranged between 136 and 323 μmhos, with most values in the 200's. Pond #13 had slightly lower values (136–196 umhos) than the other two ponds (Table 2).

Nutrient values, BOD values, and coliform levels are listed in Table 3.

Table 3. Water chemistry values from selected Nags Head Woods ponds, May 1987.

	Pond			
Parameter	Center	#13	Clear	Frog Pen
Chlorophyll-a (μg/l)	88	8	83	26
NH_3 (mg/l)	0.03	0.26	0.01	0.11
Tot. Kjeldahl Nitrogen (mg/l)	0.9	1.2	1.2	1.1
NO_3 (mg/l)	0.02	0.04	0.02	0.02
Tot. Nitrogen (mg/l)	0.92	1.24	1.22	1.12
PO_4 (mg/l)	<0.01	0.09	0.01	0.01
Tot. Phosphorus (mg/l)	0.11	1.3	0.23	0.29
BOD (mg/l)	5.9	3.9	2.5	3.0
Fecal coliform (No./100 ml)	<10	<10	20	100

DISCUSSION

The small size of the ponds at Nags Head Woods and the dense mats of vegetation present at the time of sampling are probably the major factors affecting the composition of the benthos. Limited water circulation and high summer water temperatures result, because of the small size and shallow depths of the ponds.

Aquatic vegetation provides substrate and food for many aquatic organisms. Conversely, large amounts of decomposing benthic vegetation may deplete the oxygen supply during the decomposition process. Although no DO levels less than 1 mg/l were in the water column, observations of gas bubbles coming from the sediments, as well as the smell of methane indicated anoxic conditions were present within the bottom sediments. No organisms, except worms and chironomids in Center Pond, were found in the petite ponar grab samples.

Most of the organisms collected were associated with vegetation. Odonates and coleopterans had the highest number of taxa within this habitat (Table 1).

Members of the odonate families, Libellulidae, Aeshnidae, and Coenagrionidae, all sprawlers or climbers, are usually found in dense vegetation in still waters (Brigham *et al.* 1982). *Erythemis simplicicollis* and *Pachydiplax longipennis* of

Table 4. Number of macroinvertebrate taxa collected by major groups in selected Nags Head Woods ponds, 1987.

	Pond			
Group	Clear	Frog Pen	Center	#13
Mollusca	1	2	3	4
Hirudinea	1	1	2	2
Oligochaeta	3	3	2	2
Crustacea	2	2	2	3
Ephemeroptera	0	1	1	0
Odonata	10	3	5	3
Coleoptera	13	4	5	9
Megaloptera	1	0	0	0
Diptera: Chiron.	3	3	6	5
Diptera: Misc.	3	2	2	4
Heteroptera	3	4	1	4
Other	1	0	1	2
Total	41	25	30	38

the libellulids (7 taxa) were collected from all four ponds, the other five taxa from only Clear or Center ponds. Clear Pond had the most odonate taxa (10), possibly related to the reduced amount of vegetation there, while Frog Pen Pond and Pond #13 had the least number of odonates (3 taxa).

Fifteen taxa of beetles were found in the four ponds sampled. Of the seven families collected, the gyrinids are usually surface dwellers, whereas the other six commonly occur in small water bodies with dense aquatic vegetation (Brigham *et al.* 1982). Noterids are almost always associated with masses of vegetation, which may explain their absence in Center Pond, where no dense vegetation was found. In Clear Pond, with its patchy distribution of vegetation, noterids were found within, but not away from, the vegetation.

The dytiscid beetles were represented by seven taxa, with only *Hydrovatus pustulatus* found in all four ponds. The haliplid, *Peltodytes sexmaculatus* was also found in all ponds, as was the hydrophilid, *Tropisternus glaber.* Clear Pond had the largest beetle community (13 taxa), followed by Pond #13 (9 taxa), Center Pond (5) and Frog Pen Pond (4).

Heteroptera were distributed throughout the pond system, except in Center Pond, where only *Belostoma* was collected. One specimen of the mayfly, *Caenis,* a common inhabitant of streams and ponds with low oxygen levels, was collected from each of Frog Pen and Center ponds.

The orders Amphipoda (*Crangonyx* and *Hyallela azteca*) and Isopoda (*Asellus*) were present and abundant in all four ponds. These orders are common aquatic organisms, often found in areas with high nutrients (NCNRCD 1986).

Molluscs are the only other group that was abundant and widespread throughout the pond system. The fingernail clam, *Sphaerium,* and the snails, *Physella* and *Menetus dilatus* were present in three out of four ponds (Table 1). *Pseudosuccinea columella* was found only in Pond #13. Clear Pond appeared different from the other ponds as *Sphaerium* was completely absent and only one specimen of *Physella* was collected. *Sphaerium* was dominant or abundant at all the other ponds (Table 1) and is known from an unnamed freshwater pond near Bodie Island (Beetle 1967). The lower pH levels in Clear Pond (5.2–5.6) may have been too acidic for mollusc survival.

The chironomids collected are all taxa associated with low dissolved oxygen conditions, especially *Chironomus, Kiefferulus dux, Einfeldia,* and *Endochironomus* (Saether 1979). Specimens of *Einfeldia* group A (Wiederholm 1983) collected from Center Pond were unusual and further verification of species identification is being pursued. The low number of midges found in the ponds is probably a reflection of the poor substrate conditions. Other diptera collected included *Chaoborus punctipennis,* Culicidae, Ceratopogonidae, as well as marsh and crane fly larvae.

Five taxa of leeches (Hirudinea) were found (Table 1). All were rare except for *Erpobdella/Mooreobdella* which was abundant on the *Typha* (cattails) in Pond #13.

Oligochaetes were present in all ponds and the taxa collected (especially *Dero*) were again indicative of low dissolved oxygen levels.

All four ponds appeared to have a similar benthic fauna, although they were different in size and in the amount and type of aquatic vegetation present. Clear Pond differed from the other ponds in having a much higher number of beetles and odonates, but no *Sphaerium* clams (Table 1). The reduced benthic fauna in

Frog Pen Pond could be a reflection of either the change in dominant vegetation type from rooted to floating, or the difficulty in processing samples due to the mass of floating vegetation. Center Pond also had a low number of taxa present. This pond had less vegetation and was deeper than the other ponds sampled (Table 3). Likewise, its shoreline dropped off more steeply than it did in the other ponds. This condition provided less littoral area for the benthic organisms to inhabit.

The above differences noted among ponds can only be tentative as they are based on limited qualitative sampling. Seasonal changes in fauna are likely (Mittlebach 1981) and more sampling would result in a more complete evaluation of the benthic community.

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PRE- AND POST-DROUGHT FISH SURVEYS OF SELECTED FRESHWATER PONDS LOCATED IN NAGS HEAD WOODS, NAGS HEAD, NORTH CAROLINA

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ABSTRACT

A pre-drought seine survey of all 33 Nags Head Woods freshwater ponds in 1983 produced five species of fishes. A post-drought resurvey of seven selected ponds in 1987 found five species inhabiting the ponds; however, two species captured in 1983 were absent in 1987 when two different species were encountered. Selected ponds occupied areas once influenced by island inlets. Ponds studied progressed from old in the north to young in the south. The resurvey was undertaken to note the effects of the 1985, 1986, and 1987 droughts on the fish faunas and pond ecologies. Two ponds were dry in 1987 and water levels in others were extremely low, otherwise ecological parameters mirrored those noted prior to the droughts.

INTRODUCTION

Seventy-three freshwater ponds are scattered along the 80 km of the Outer Banks of North Carolina stretching from the Virginia/North Carolina state line, including Bodie Island, Dare County, southward to Oregon Inlet (Fig. 1). Fourteen ponds occur north of Run Hill dune (the northern boundary of Nags Head Woods Preserve (NHW) at Boundary Street, Nags Head, North Carolina, see also frontpiece); 17 are found south of Jockeys Ridge (Nags Head, North Carolina). Thirty-three of the remaining 42 ponds, plus the Nags Head water reservoir, are clustered in NHW; nine ponds (numbered 56–64) lay adjacent to and just south of the woods (Fig. 1).

A 1983 seine survey of all 73 ponds north of Oregon Inlet yielded 25 species comprising 14 families of fishes occupying 48 of the 73 ponds sampled (Schwartz 1983). Twelve of the 33 ponds within the NHW pond complex, stretching from Run Hill southward to Ocean Acre Drive, lacked fishes in 1983.

The NHW area experienced, following the 1983 fish survey, severe droughts in 1985, 1986, and especially 1987. Pond water levels were greatly reduced, with some ponds even drying up until replenished by fall rains. A resurvey of seven selected NHW ponds was instituted in 1987 to determine the effects of the droughts on the population structure and survivability of the fishes known therein. It compared numbers and species of fishes captured in 1983 to those sampled in 1987 as well as noted environmental and ecological parameters between years, in an attempt to explain any differences noted.

METHODS

Seine collecting methods were identical during each survey. Several passes of a knotted nylon seine (1.2 × 7.5 m × 15 mm stretched mesh) were made through each pond until all areas were sampled and with repeated seinings no additional fish species are captured. Sampling occurred between 21–23 September 1983 and 25–26 August 1987. Field preservation was in 10% formalin with subsequent

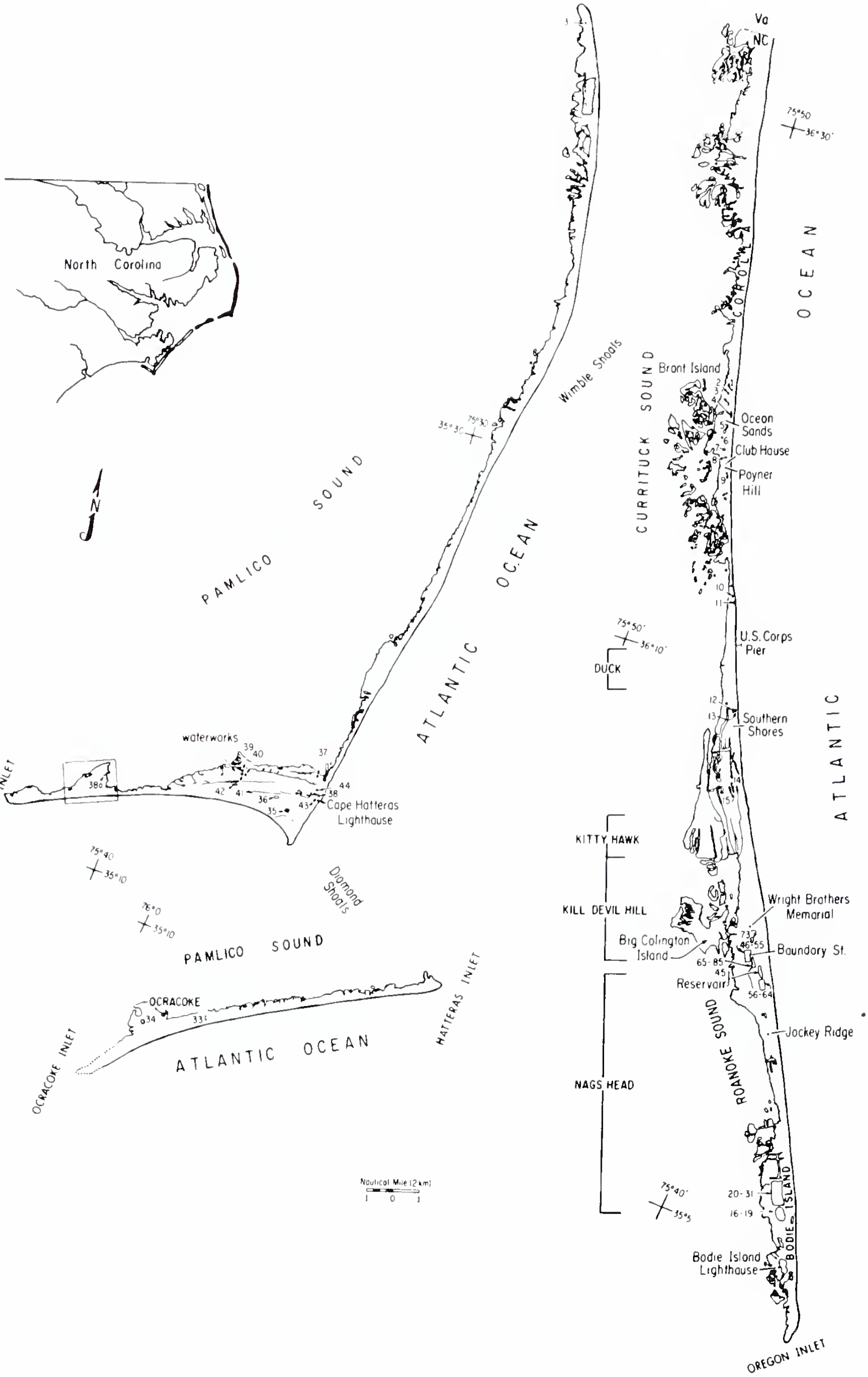

Fig. 1. Map of the Outer Banks from the Virginia/North Carolina state line southward to Ocracoke Inlet illustrating locations of freshwater ponds sampled in 1983 and/or 1987. Land mass on extreme right contains ponds 45–85 located in or near Nags Head Woods Nature Conservancy preserve Nags Head, North Carolina.

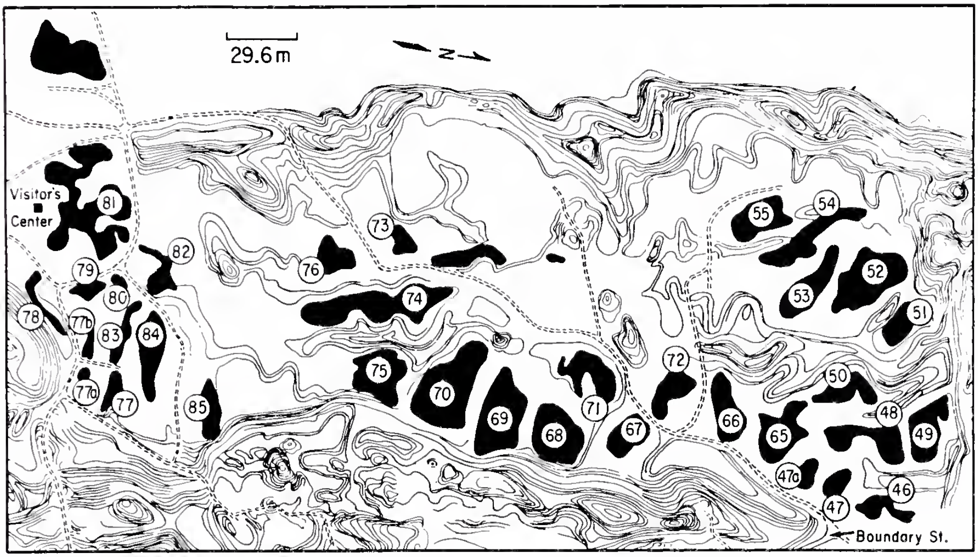

Fig. 2. Enlargement of Nags Head Woods ponds area. Numbers correspond to ponds surveyed in 1983 and/or 1987. See Tables 1 and 2 for specific pond data.

rinses in freshwater and final storage in 70% isopropyl alcohol. All fish specimens were deposited in the University of North Carolina-Institute of Marine Sciences curated collection at Morehead City.

Preserved specimens were measured to the nearest 0.1 mm standard length (SL), weighed on a Mettler electronic 3000 balance to 0.1 g. Other organisms collected in the field were similarly treated and then sent to specialists and museums elsewhere for final deposition.

Environmental conditions noted were: water and air temperature (Taylor pocket thermometer), pH (either with portable Fisher 103 or Beckman 21 meters), oxygen (YSI portable model 57 meter), pond substrate texture and composition, water color and depth, vegetation, surrounding shoreline flora, and wind conditions.

Selection of seven NHW ponds for resurvey in 1987 was predicated on several criteria: the ponds were located along the North-South length of the woods and occurred between Run Hill and the visitors center at Ocean Acres Drive, they also straddled areas that were once occupied by old inlets (Stick 1958) in order to reflect age, filling in, and progressive substrate and fish faunal change, and they were prone to exhibit the effects of the successive droughts on the area.

OBSERVATIONS

1983: Twelve of the 33 NHW ponds sampled in 1973 were devoid of fishes (ponds 47, 50, 51, 53, 55, 65, 66, 71, 72, 74, 75, 76, Fig. 2) (Schwartz 1983). Fish abundance within any of the comparative ponds was low (Table 1). Five species comprised the overall fish fauna of those ponds in 1983. They were: mosquitofish (*Gambusia holbrooki*), rainwater fish (*Lucania parva*), pumpkinseed (*Lepomis gibbosus*), bluegill (*Lepomis macrochirus*), and largemouth bass (*Micropterus salmoides*).

Ecological and environmental data of pond size and depth, substrate type and composition, water color, pH, and oxygen content varied little between ponds (Table 2). Pond sizes varied between 3 and 150 m^2 in surface area, pond depths ranged 0.1–3.0 m. Ponds located at the north end of the woods (south of Run Hill) possessed hip deep muck substrates full of leaf litter or decaying pine needles. Northern pond water colors were tea or brown whereas ponds near the southern limits of the woods (south of pond 75) were clear and possessed sand substrates

Table 1. Fishes seined from selected Nags Head Woods (NHW) ponds in 1983* and 1987.

Pond number	Species															
	Nc		Ga		Lp		Lg		Lm		Pn		Ms		Total	
1983 1987	1983	1987	1983	1987	1983	1987	1983	1987	1983	1987	1983	1987	1983	1987	1983	1987
52			13	Dry					2	Dry					15	—
54			5	Dry											5	—
49			—	10	8	—									8	10
65			—	6											—	6
67	—	6	15	—									1	—	16	6
75			5	—			1	—	4	7					10	7
81	—	1	17	—			3	—	2	105	—	4	4	14	26	124
	—	7	55	16	8	—	4	—	8	112	—	4	5	14	80	153

* See Schwartz 1983.

Nc = *Notemigonus crysoleucas*; Ga = *Gambusia holbrooki*; Lp = *Lucania parva*; Lg = *Lepomis gibbosus*; Lm = *Lepomis macrochirus*; Ms = *Micropterus salmoides*; Pn = *Pomoxis nigromaculatus*.

Table 2. Ecological and environmental conditions prevailing 1983 and 1987 during fish seine surveys of selected Nags Head Woods (NHW) ponds.

Pond number	Environmental parameter															
	Size M		Depth m		Color		Water °C		pH		O_2ppm		Veg*		Substrate m	
1983 1987	1983	1987	1983	1987	1983	1987	1983	1987	1983	1987	1983	1987	1983	1987	1983	1987
52	30 × 40	dry	2.5	dry	tea	dry	20.0	—	7.3	—	7.0	—	C, L	—	mud	dry
54	15 × 60	dry	2.75	dry	tea	dry	20.0	—	7.25	—	7.3	—	L	—	mud	dry
49	70 × 75	70 × 75	2.0	2.0	tea	tea	20.0	29.5	7.2	7.1	6.4	7.5	C, P	P	0.5 mud	0.5 muck-sand
65	15 × 30	15 × 30	3.0	1.0	tea	tea	25.5	30.0	7.0	7.0	7.0	7.6	L, Pe	L, Pe	1 muck	1 muck
67	20 × 40	20 × 20	3.0	0.03	black	black	22.5	29.5	7.0	7.0	7.2	7.4	—	—	1 muck	1 muck
75	40 × 45	40 × 35	1.0	1.0	clear	clear	22.5	30.0	7.2	7.1	6.2	6.8	—	L, M	1 sand	1.5 mud sand
81	10 × 150	10 × 150	3.0	3.0	clear	clear	21.5	28.6	7.7	7.6	8.2	8.0	C, L	C, L	0.5 sand	0.5 sand

* C = Chara; L = *Lemna*; M = Microcystis; P = Pennywort; Pe = Peat.

(Schwartz 1983; Table 2). Depending on the location, depth, and age of a specific pond, *Lemna* and pennywort were often dense, i.e. pond 65 (Schwartz 1983).

1987: Seven ponds were resurveyed in 1987; from north to south they were ponds 52, 54, 49, 65, 67, 75, and 81 (visitor center). See Fig. 2 for precise location of each pond within the NHW complex. Again northern ponds were representative of old inlet influenced ponds while those in the south were of recent origin.

Two ponds (52 and 54, Fig. 2) could not be sampled in 1987 as they were dry (Table 1). Pennywort and grasses indicated the area of each pond which was once covered by water. The remaining ponds were similar in size, substrate etc. composition, as noted in 1983, except water levels were much lower, i.e. pond 67 had only 90 mm of water overlying +1 m of muck in 1987, whereas in 1983 the water depth was 0.5 m. Water temperatures, pH's, and oxygen levels of the five remaining ponds mirrored 1983 observations (Table 2, Schwartz 1983).

Five species of fishes were collected (Table 1). These were: golden shiner (*Notemigonus crysoleucas*), mosquitofish, bluegill, black crappie (*Pomoxis nigromaculatus*), and largemouth bass. The major difference between surveys was that two new fishes were collected in 1987 while two collected in 1983 (rainwater fish and pumpkinseed) were absent. The total number of fishes captured in 1987 exceeded the 1983 catch 153 vs. 80 (Table 1).

Precipitation

Rainfall (Table 3) and Nags Head water reservoir water level data (Table 4) reinforce the comments that the NHW experienced droughts in 1985–1987. Note, Table 3, that precipitation for nine of the 16 months between 1984 and 1987 was below monthly averages. Likewise area annual average/month rainfall averages (January 1984–July 1987) were less than the 1980–86 average of 81 mm.

The lack of precipitation was evident in 1987 (Table 4), as several ponds were dry (ponds 52, 54) or almost devoid of water (pond 67). Likewise, Nags Head reservoir waters were hardly more than one meter above pool or sea level in 1987. Note that they were also low six of the 8 summer months between May 1986–August 1987 (Table 4). Hurricane Charlie caused the area high precipitation noted in August 1986 (Tables 3, 4). This was also not reflected by the high (4.83 m) August Nags Head reservoir water level (Table 4) because of water usage.

DISCUSSION

Historical and Geographic Setting

The 80 km Outer Banks (including Bodie Island) area from the Virginia/North Carolina state line southward to Oregon Inlet is a narrow (0.4 km at Duck to 2.5 km wide at Kill Devil Hills) sand dune, sparsely covered with live oak, hardwoods, and scrub vegetation that is often overwashed during severe winter or hurricane storms by the adjacent ocean or sound waters. The Banks are oriented north to south and are bordered on the east by the Atlantic Ocean. Currituck Sound contains the western edge of the island southward to near Southern Shores, North Carolina and U.S. Route 158. Albemarle Sound abuts the island's western shore south of U.S. 158 southward to Nags Head. Roanoke Sound lies southward of the woods to Oregon Inlet (Fig. 1). Tidal amplitudes in Currituck, Albemarle, and Roanoke sounds are less than 0.5 m or usually none. Atlantic Ocean tides are

Table 3. Monthly precipitation (mm) January 1984–July 1987 measured at Duck, North Carolina. Monthly averages are compared between years and 1980–86 monthly and annual averages. Data from annual reports of Measurements and Analysis Program of U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, Field Research Facility, Kitty Hawk, North Carolina, H. Miller, Oceanographer.

	Year				
Month	1984	1985	1986	1987	1980–1986
					Ave./mo.
January	70	112	44	138	91
February	71	68	20	44	74
March	84	35	38	110	81
April	111	0	66	124	89
May	**86**	**35**	**20**	**31**	**71**
June	**27**	**62**	**89**	**36**	**77**
July	**123**	**67**	**96**	**35**	**87**
August	**177**	**30**	**221***	**53**	**110**
September	115	71	42	34	83
October	20	143	17	74	62
November	26	145	46	58	87
December	28	4	68	47	70
Ave./Mo. precipitation	78	66	64	65	81

Boldface indicates months when precipitation was below monthly averages.
* Effects of Hurricane Charlie.

about 1 m except during hurricanes when ±2 m surges can occur, overwashing the island complex, especially north of Duck and on Bodie Island to the south (Pilkey *et al.* 1980). Such areas have low land reliefs of ±1 m. Land elevations in NHW often attain 15 m. Run Hill, a vast sand dune at the north end of the woods, rises to 17 m while Jockeys Ridge, to the south, is the highest natural sand dune in the eastern United States that rises to elevations of 51.4 m. Currituck Sound waters are fresh although following inlet formation have been sporadically saline, whereas Albemarle Sound waters range 5–10 ppt salinity. Roanoke Sound salinities range 5–32 ppt.

Historically, of the 25 inlets accorded the Outer Banks of North Carolina (Stick, 1958), 10 existed for varying lengths of time across the 80 km stretch north of Oregon Inlet. Such actions further divided the Virginia-Oregon Inlet Banks into

Table 4. Nags Head Reservoir water levels (in meters above sea level) 1985–87. Data provided by J. Richardson of Nags Head, North Carolina reservoir water department.

	Reservoir water level (m)	
	Year	
Month	1986	1987
April	Na	2.03
May	**Na**	**2.13**
June	**1.18**	**1.95**
July	**1.16**	**1.61**
August	**1.10**	**1.29**
Average	1.15	1.80

Drought months in bold face. Na = not available.

a Virginia state line to New Currituck Inlet (North Banks) from Currituck Inlet or New Currituck Inlet to Roanoke Inlet (just north of Nags Head), Bodie Island, and old Roanoke Inlet segments (Stick 1958). The many Northeast-Southwest area (Fig. 2) ridges that abound in NHW are possible remnants of old inlets that prevailed near Kitty Hawk, North Carolina.

The first good description of the Banks was by Barlowe in 1584 (in Stick 1958). Early white inhabitants, other than Indians and true settlers, were stockmen, runaways, whalers, and a few landsmen. Kitty Hawk was an early resort holiday center for people from the nearby mainland region. Thorpe (in Stick 1958) describes such activities in what seems to be the earliest reference (1850) to the freshwater ponds on the banks, "the desciple of Walton can fish here without the aid of 'complete angler' and catch an abundant supper. Then there are excursions to the fresh ponds . . ." (Stick 1958). The freshwater pond 7.2 km south of the old inlet at Kill Devil Hills may be the remnant of the inlet that may have connected the Roanoke Sound by a creek there known as "the run." Ponds were also noted 19 December 1716 in land grants to William Johnson "on ye E side of ye great fresh pond." Another deed to Charles Thomas 16 May 1737 noted "50 acres on the northern banks joyning the great fresh pond beginning at or near the Run side" (in Stick 1958). Thayer (in Stick 1958) also refers to a 1.6 km long bottomless pond nearby of Kitty Hawk, North Carolina. This persists today as the Nags Head-Kill Devil Hills water reservoir.

Island Origin

Two theories have persisted through time regarding the origin of barrier islands as a result of de Beaufort's (1845) influence: that they develop from offshore barriers and that they develop from migrating spits (Gilbert 1885; Fisher 1967). Pierce (1969) and Pierce and Colquhoun (1970), studying North Carolina's Outer Banks, presented the most convincing data as to the origin of the present banks and are suggestive of the future of the banks. Pierce and Colquhoun (1970) showed that the Outer Banks, from the Virginia state line South to Hatteras, North Carolina, was a primary barrier island (an area built upon material that is terrestrial in origin and/or has been exposed to weathering). They also believed that "further evolution will lead to the destruction of all barriers by driving them onto the mainland, so that evidence necessary for reconstruction is removed." One should also consider that not only were many inlets cut and naturally filled in that area of NHW studied in 1983 and 1987 but that the island could have been flooded or cut across by the ancient Pliocene Greater Roanoke River as it passed out into the Atlantic (Hocutt *et al.* 1986).

Fishes

Fishes found north of NHW (brown bullhead *Ictalurus nebulosus*, American eel *Anguilla rostrata*, ladyfish *Elops saurus*, and redfin pickerel *Esox americanus*) are derivatives from the ocean, mainland, or Currituck Sound. They may have been carried there during overwash from the sound or ocean or as transports down the Greater Roanoke River. Most of the fishes north and south of NHW, seven species, are representatives of more saline tolerant fishes that have or do adjust to freshwater conditions. These include the inland silverside, *Menidia beryllina*, and American eel. Most marine fishes are introductions from nearby

Albemarle Sound or Currituck Sound when both were saline, following inlet formation and island inundation. The exception is the Nags Head-Kill Devil Hills water reservoir just northeast of NHW where Currituck Sound derivatives (Schwartz 1983), longnose gar (*Lepisosteus osseus*), carp (*Cyprinus carpio*), gizzard shad (*Dorosoma cepedianum*), and white perch (*Morone americana*) occur along with largemouth bass.

Subtracting the reservoir's four and the seven species found elsewhere on the Banks, eight freshwater species and six low saline freshwater tolerant fishes should comprise the fish fauna of the NHW ponds. Instead five species were encountered during the 1983 and 1987 surveys (Table 1). However, two species, golden shiner and black crappie, were taken in 1987 but not during 1983 (even though the golden shiner was known from pond 73 in 1973, see Fig. 2 for pond location). Two species, rainwater fish and pumpkinseed were collected in 1983 but not in 1987.

Notemigonus crysoleucas—golden shiner. This species was collected only in 1987 in ponds 67 and the visitors center (pond 81). It was known from the area by a collection in pond 73 in 1973. Strangely it did not exist in pond 67 in 1983 where largemouth bass had been bait bucket introductions by local fishermen. Perhaps it too was a bait bucket introduction into pond 67 in hopes of sustaining the largemouth bass known therein in 1983.

It is unlikely that the golden shiner will become a valuable member of the pond 67 fish fauna as during severe drought years, as in 1985–87, the pond will dry up (note Table 2 only 0.03 m of water existed in 1987). Likewise specimens caught in 1987 ranged 62–72 mm SL ($\bar{x}$ 68.5 mm) and were not reproducing. The golden shiners of pond 81 were 99.4 mm SL.

Gambusia holbrooki—mosquitofish. More (55 vs. 16) of this hearty environment-tolerant species were collected in 1983 than in 1987 (Table 1). Its absence from ponds 67, 75, and 81 project dire consequences for the fishes of those ponds as it serves as forage for many of the resident game fishes. Absence from ponds 67 and 81 can be, in part, attributed to the large bluegills and especially largemouth bass that exist there.

Lucania parva—rainwater fish. This hearty cyprinodont was taken in pond 49 near Run Hill in 1983. It was absent from all 1987 resurveyed ponds. The sandy substrate of ponds 49 and 81 should support this diminutive species, especially in pond 49, where no carnivores exist.

Lepomis gibbosus—pumpkinseed. This pretty sunfish is now (1987) known only from ponds 75 and 81. It prefers clean, sand-substrate ponds where it can dig pit nests during spawning. While ponds 75 and 81 meet all these requirements bluegills seem to be out-competing the pumpkinseed, as evidenced by the several year classes present. The largemouth bass may also find it easier to swallow them than the deeper bodied bluegill.

Lepomis macrochirus—bluegill. Bluegills occurred only (in 1983 and 1987) in ponds 75 and 81. They inhabited pond 52 in 1983. Drying of that pond in 1987 or earlier caused its demise there. The largest specimen collected (pond 81 in 1987) was 160 mm SL and six years old.

Pomoxis nigromaculatus—black crappie. This centrarchid, although known from pond 46 in 1983 (Fig. 2), was not captured in any other NHW pond in 1983. Its 1987 occurrence in pond 81 can be accounted for by culvert connection introductions from nearby ponds 80 and 82 (see Fig. 2 for pond locations). Their sparse numbers in pond 81 suggest recent introduction. Its numbers are also being held in check by the larger predators, largemouth bass that inhabit pond 81.

Micropterus salmoides—largemouth bass. Two ponds harbored largemouth bass, pond 67 in 1983 and pond 81 in 1987. Sportsmen undoubtedly accounted for its introduction and collection in pond 67 and 81 but connections to other ponds near 81 may also have played a role in its introduction there. Lack of adequate habitat (muck), low water depth 0.03 m, and unusually high water temperatures, mean 30 C (Table 2) all explain the absence of largemouth bass from pond 67 in 1987. Pond 81 largemouth bass have proliferated and in 1987 at least three year classes existed, the largest bass being 193 mm SL and three years old.

CONCLUSIONS

The fish composition of some if not all NHW ponds continues to change. The change is for the worse. The northern ponds, being the oldest, present the poorest habitats for existence and are subject to drying and filling in (i.e. Run Hill as a result of encroaching sand). Continued natural leaf and pine needle accumulations in all ponds will prevent water qualities to improve or to support fishes. Ponds such as 65 and even 75 are aging rapidly, as evidenced by the thick, chest-deep peat substrates overlain by *Lemna* and pennywort.

Only ponds south of pond 75 hold promise for continued fish existence. Introduction of a variety of forage species such as: killifishes (*Fundulus* spp.), golden shiners, and mosquitofishes will aid the survival of the existent populations. Otherwise species population vagaries, i.e. bluegill or largemouth bass, that now influence or dominate NHW ponds will become older, stunted, and die. All we can presently expect is that a few large old fishes will prevent the spawning and survival of all other species. Eventually, as the ponds age, they too will disappear. Only replenishment by man or reintroduction from the nearby sounds or ocean will prolong the existence of fishes in NHW ponds.

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A SURVEY OF THE AMPHIBIANS AND REPTILES OF NAGS HEAD WOODS ECOLOGICAL PRESERVE

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ABSTRACT

A survey of the amphibians and reptiles of Nags Head Woods Ecological Preserve was conducted between 11 April 1987 and 15 September 1987. Special attention was given to eight ponds selected by The Nature Conservancy in an effort to identify the species using them. Standard herpetological survey techniques, including drift fences, were employed to survey aquatic and terrestrial habitats. Amphibian and reptile species documented from the preserve increased from 25 to 41 during the survey. Twenty-three species are directly dependent upon the freshwater pond habitats. On the Outer Banks north of Cape Lookout, 18 species are known only from the vicinity of Nags Head Woods. New species for the Outer Banks documented during this survey include *Carphophis amoenus, Deirochelys reticularia, Diadophis punctatus,* and *Seminatrix pygaea.* Relict populations, peripheral populations, and populations with questionable taxonomy are represented in the preserve's herp fauna. Protecting the unique diversity of Nags Head Woods, because of its ecological, biogeographical, taxonomic, and aesthetic importance, should be a high priority.

INTRODUCTION

The Nature Conservancy (TNC) properties, Nags Head Woods Ecological Preserve (NHWEP), on Bodie Island constitute a large portion of the relatively undisturbed habitat remaining in the vicinity of Nags Head and Kill Devil Hills, Dare County, North Carolina (Fig. 1a). Extensive development in the area, and the potential threats this development might have on the water resources and various plant and animal populations in Nags Head Woods (NHW), prompted TNC personnel to invite specialists in various biological disciplines to collect baseline data on the natural resources in NHWEP. The study period began 11 April 1987 and concluded on 1 September 1987. Research efforts focused on eight ponds designated by TNC. Additional information gathered from other areas in the preserve was welcomed.

The North Carolina State Museum of Natural Sciences agreed to assist with the research by surveying the amphibian and reptile populations in and around the designated ponds, with the following objectives in mind: (1) Determine the species present; (2) Determine if any species are of particular concern in relation to low populations, general rarity, unique taxonomic or distributional status, impending development, etc.; (3) Correlate species occurrence with habitat types and availability so predictions can be made concerning species survival based on habitat survival; (4) Speculate on the current status of species relative to former status, based on limited faunal surveys made in the past; (5) Make recommendations, where appropriate, for improvement of habitats and/or protection of species; (6) List unique or special interest items that could be pointed out to casual visitors; and (7) Make recommendations for future monitoring of important species.

NHW consists of approximately 486 forested ha of which about 304 ha currently are protected by TNC (pers. commun., TNC). See Burney and Burney (1987) and Otte *et al.* (1984) for characteristics of the area and the freshwater ponds located therein.

NHW has long been recognized as unique from a herpetological viewpoint. Such species as the Marbled Salamander, Redback Salamander, and Pine Woods Snake have been known to occur there for many years (Martof *et al.* 1980). These species are known from no other area on the Outer Banks of North Carolina north of Cape Lookout. Rumors and unverified reports of other species, characteristic of the mainland, occurring in Nags Head Woods persist. A need for a more comprehensive survey of the amphibians and reptiles of the area was apparent to clarify the species present and to document the unique diversity in this northern section of the Outer Banks.

MATERIALS AND METHODS

Techniques and materials commonly used to survey amphibian and reptile populations were used in Nags Head Woods. Qualitative pond sampling was with dipnets, minnow traps, turtle traps, hand capture, day and night visual searches, and by listening for frog calls. Terrestrial habitats were qualitatively sampled using potato rakes to turn leaf litter and other surface cover, visual searches of the ground and vegetation in a habitat, monitoring species killed on the roads, and observing day and night activity of species crossing the roads. Drift fences (Gibbons and Semlitsch 1982) set at two locations contributed to the qualitative sampling of terrestrial habitats near freshwater ponds and resulted in the gathering of quantitative data in a local setting. The NHWEP pond numbers referred to in the text, and the location of the two drift fence sites are noted in Fig. 1b. Figure 2 expands on the drift fence configurations used and each general site layout. A coordinate system provided by TNC was used to help document locations in NHW.

On site active samplings by North Carolina State Museum (NCSM) personnel were made on 11 and 12 April, 26–29 May, and 14–16 July 1987.

Drift fences were installed on 28 and 29 May 1987. Drift Fence #1 (DF1), located at coordinates 35Dad, was set at the boundary between hardwood forest and an old field, and near pond 28.3. The goal of setting DF1 at this particular location was to capture species associated with the old field, hardwood forest, and those entering and exiting the area of the freshwater pond. DF1 consisted of two funnel traps, two 19 l pitfall traps, and three 7.6 m sections of 30.5 cm high, 3.2 mm mesh hardware cloth fences set in a roughly linear manner (Fig. 2). Drift Fence #2 (DF2), located at coordinates 35Dda, was set in mixed pine/hardwood forest near backwaters of pond 28.4. The goal of setting DF2 at this site was to sample the mixed pine/hardwood habitat and catch species moving in and out of the pond habitat. DF2 consisted of two funnel traps, one 19 l pitfall trap, and three 7.6 m sections of the same type fencing used with DF1 set with the fences radiating from the pitfall trap (Fig. 2). Both fences were shut down from 19 June until 6 July to discourage raccoon predation. While the traps were operating, they were checked almost every morning between about 0900 and 1100 hr from 29 May to 15 August, and approximately every second or third day from 15 August to 1 September. Captured animals not retained for voucher specimens were released in the area of capture.

The research collection at the North Carolina State Museum of Natural Sciences was checked for prior collections at or near NHWEP. Additionally, records from most of the major museums in the country and some minor collections were scanned in an effort to establish what species were known from NHWEP. Collections (acronyms in parentheses) referred to in this report are as follows: American Museum of Natural History (AMNH), Carnegie Museum (CM), Duke University (DU), Florida State Museum (UF/FSM), North Carolina State Museum of Natural Sciences (NCSM), National Museum of Natural History (USNM), Ricks College (RC). Voucher specimens with Alvin L. Braswell (ALB) field numbers are being used in research projects and will be placed in the NCSM collection at a later date. All the available voucher supported records and observations made during the survey period were compiled using dBase III Plus.

RESULTS

Twenty-one amphibian and reptile species were found in and around the primary and secondary study ponds (Table 1). Only two additional species directly associated with the freshwater habitats in NHWEP were found in other locations:

Farancia erytrogramma in pond 8, and *Scaphiopus holbrooki* in a ditch at the eastern boundary of NHWEP property.

Drift fence sampling accounted for 27 species of amphibians and reptiles. For many species, the numbers captured using this technique far exceeded other techniques employed. Four species (*Seminatrix pygaea, Storeria dekayi, Nerodia erythrogaster,* and *Thamnophis sauritus*) were captured only by this technique. Total captures were 1,450 (Table 2); some individuals could have been caught more than once. Three species dominated the captures: *Ambystoma opacum, Gastrophryne carolinensis,* and *Rana utricularia.*

Prior to the survey, 25 species had been documented from the preserve. On conclusion of this survey, the number of amphibians and reptiles documented from NHWEP was 41. All but two of these species (*Cnemidophorus sexlineatus* and *Heterodon platyrhinos*) were observed during the survey period. Six additional species have been recorded near the preserve and probably occur in NHWEP: *Bufo quercicus, Elaphe g. guttata, Farancia a. abacura, Malaclemys terrapin, Nerodia sipedon,* and *Siren lacertina.*

One of the unique features of NHW is the presence of mainland species found nowhere else on the Outer Banks north of Cape Lookout (Table 3). Newly documented species in this category, as a result of this survey, include *Carphophis amoenus, Deirochelys reticularia, Diadophis punctatus,* and *Seminatrix pygaea.* A number of species (Table 4) are well adapted to coastal conditions and are widespread on the Outer Banks (Conant and Lazell 1973; Engels 1942; Lazell and Musick 1973; Quay 1959; NCSM files). Many of these species are commonly found on other Atlantic Coast barrier islands (Gibbons and Coker 1978).

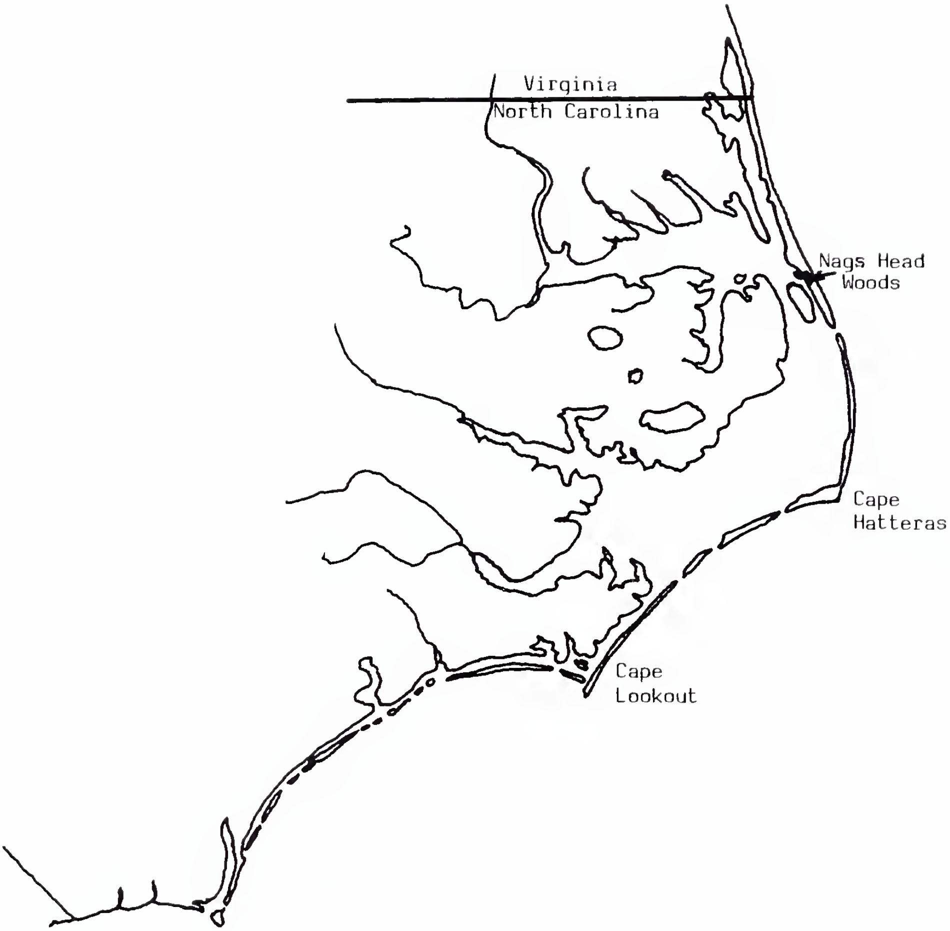
ANNOTATED LIST

Species known to occur in NHWEP are arranged alphabetically in the first part of the list. Species that probably occur in NHWEP are presented in the second part of the list. Included are statements on relative abundance, repositories and catalog numbers for voucher specimens, and other comments relevant to individual specimens or species.

Amphibians occurring in NHWEP

Acris g. gryllus: The Southern Cricket Frog is seasonally common around most NHWEP freshwater ponds, and occasionally ranges away from water. The population in the NHW/Kitty Hawk area is the only one recorded for the Outer Banks. Martof *et al.* (1980) depicted the range to include NHW. Voucher = NCSM 28433.

Ambystoma opacum: The Marbled Salamander is abundant in the mixed pine-hardwood and hardwood forests surrounding the many NHW freshwater ponds. It breeds in most ponds that contain water from at least November to June. The terrestrial juveniles and adults burrow and are hard to find, but larvae are easily captured in the spring in the shallow edges of the ponds. Fluctuating pond water levels are essential for this species to reproduce successfully. During the fall eggs are laid on land in ponds that will fill with winter rains. The eggs hatch when the nests are flooded. The population in the NHW area is the only one recorded for the Outer Banks. Martof *et al.* (1980) depicted the range to include NHW. Vouch-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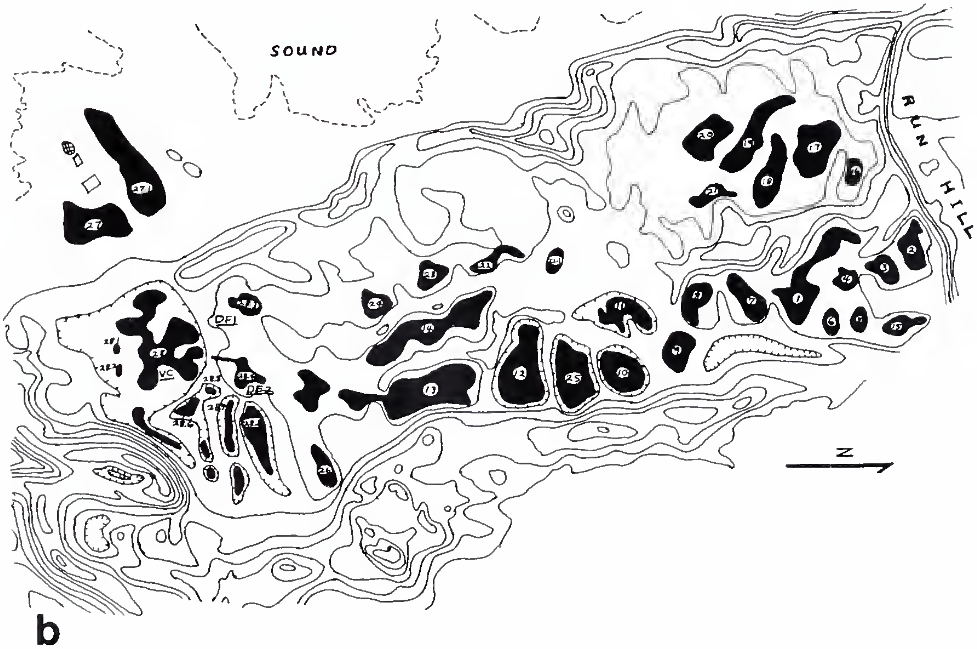
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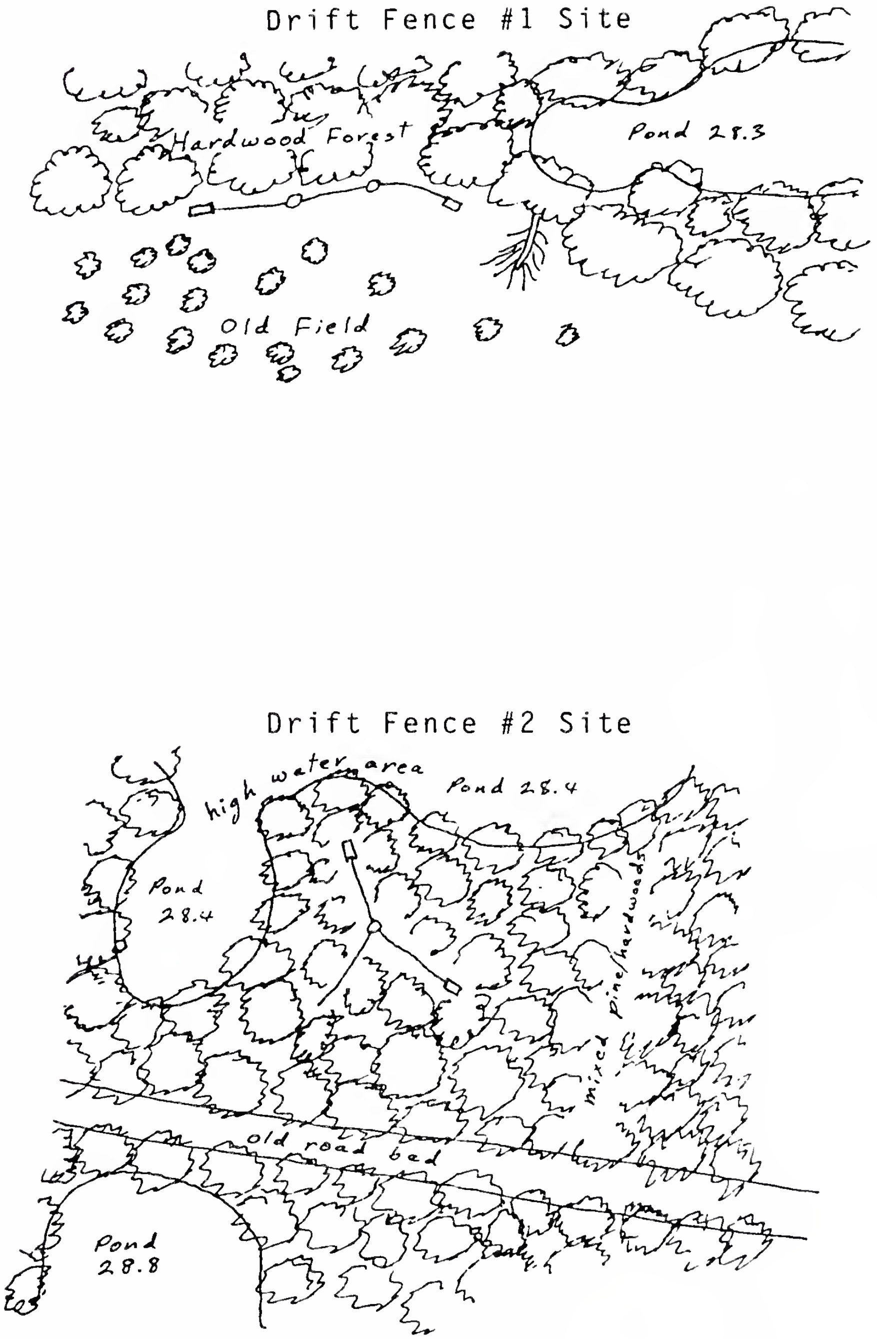

Fig. 2. Drift fence configurations and general site layouts.

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Fig. 1. a. Depicts location of Nags Head Woods on the Outer Banks. b. General map of Nags Head Woods Ecological Preserve, illustrating location of ponds and other features. VC = Visitor Center; *DF1* & *DF2* = Drift Fence Sites 1 & 2.

Table 1. Amphibians and reptiles associated with primary and secondary study ponds in Nags Head Woods Ecological Preserve, 1987.

	Pond number							
Scientific name	1	9	13	28*	2	17	19	27**
Amphibians:								
Acris g. gryllus		X	X	X		X	X	
Ambystoma opacum	X	X	X	X	X	X	X	X
Bufo cf. *terrestris*			X	X				
Bufo woodhousii fowleri		X	X	X				
Gastrophryne carolinensis		X	X	X				X
Hyla chrysoscelis		X		X			X	
Hyla cinerea	X		X	X		X	X	
Hyla squirella				X				
Notophthalmus viridescens			X	X				
Rana catesbeiana	X	X	X	X	X			X
Rana clamitans		X		X			X	
Rana utricularia	X	X		X	X	X		X
Reptiles:								
Agkistrodon p. piscivorus						X		X
Chelydra s. serpentina	X	X	X	X	X	X		X
Deirochelys r. reticularia		X			X			
Kinosternon s. subrubrum		X	X	X				
Nerodia e. erythrogaster				X				
Pseudemys r. rubriventris	X	X	X	X	X	X		
Seminatrix pygaea paludis				X				
Thamnophis s. sauritus				X				
Trachemys s. scripta	X	X	X	X	X	X	X	X

* Pond 28 complex (= ponds 28–28.8).
** Pond 27 and 27.1.

ers = NCSM 15105, 19053, 19064–67(4), 20385–88(4), 23645–46(2), 28436, 28438, 28440, 28445, 28447; CM 23599(10); DU A4451(2).

Bufo cf. *terrestris:* Toads tentatively identified as the Southern Toad occur in NHWEP, but are not as common as Fowler's Toad (*B. woodhousii fowleri*). Karyological work that may verify this species' identity is underway; voice recordings and additional morphological studies are also planned. Statements concerning this toad's significance as a member of the Outer Banks fauna and the possible origin of the population will have to wait until its identity is known. Vouchers = ALB 6200, 6284, and 6326.

Bufo woodhousii fowleri: Fowler's Toad is commonly found in many habitats on the preserve. The species is widespread on the Outer Banks (Engels 1942; Quay 1959; NCSM files). Vouchers = NCSM 19055, 19058, 19068, 28641-42(2).

Gastrophryne carolinensis: The Eastern Narrowmouth Toad is a common species that frequently is found under logs or other surface cover in NHWEP. It has also been reported from Buxton Woods (Quay 1959), Dare County, and seems to be restricted to the more extensive forest areas on the Outer Banks north of Cape Lookout. Vouchers = NCSM 28629, 28643.

Hyla chrysoscelis: Copes' Gray Treefrog is a mainland species that inhabits hardwood forests. The population in the vicinity of NHWEP represents the only known population of this species on the Outer Banks. Harper (1935) reported hearing the calls of the Common Treefrog (=*Hyla versicolor* sensu lato) in the vicinity of Kitty Hawk and Nags Head on 2–3 April 1933. This population

Table 2. Drift fence capture results for 1987 amphibian and reptile survey in Nags Head Woods Ecological Preserve.

Species	Number in DF1	Number in DF2	Total captures
Amphibians:			
Ambystoma opacum	187	567	754
Bufo sp.	2	1	3
Bufo cf. *terrestris*	1	1	2
Bufo woodhousii fowleri	16	13	29
Gastrophryne carolinensis	103	36	139
Hyla chrysoscelis	0	2	2
Hyla cinerea	1	0	1
Notophthalmus viridescens	1	1	2
Plethodon cinereus	1	0	1
Rana catesbeiana	8	7	15
Rana clamitans	11	13	24
Rana utricularia	187	229	416
frog (unidentified)	2	1	3
salamander (unidentified)	1	6	7
Reptiles:			
Carphophis a. amoenus	2	0	2
Cemophora coccinea copei	5	1	6
Coluber constrictor	5	3	8
Diadophis p. punctatus	0	2	2
Elaphe obsoleta	1	1	2
Eumeces inexpectatus	2	3	5
Kinosternon s. subrubrum	0	1	1
Nerodia e. erythrogaster	0	1	1
Ophisaurus ventralis	1	1	2
Pseudemys r. rubriventris	0	1	1
Rhadinaea flavilata	1	0	1
Scincella lateralis	1	8	9
Seminatrix pygaea paludis	1	0	1
Storeria dekayi	5	3	8
Terrapene c. carolina	0	1	1
Thamnophis s. sauritus	2	0	2
Total	547	903	1,450

undoubtedly depends on the hardwood forest and freshwater ponds in the NHW area for its survival. There are taxonomic problems between this species and the very similar Gray Treefrog (*H. versicolor*). A specimen from NHWEP is being karyotyped to determine species identification. Vouchers = DU A4447(4); NCSM 28648, 28742, 28744.

Hyla cinerea: The most common, most frequently seen, and most often heard treefrog in NHWEP is the Green Treefrog. This species occurs in a variety of habitats ranging from forests to grasslands as long as there are ponds with extensive aquatic vegetation available for breeding. It is widely distributed on the Outer Banks (Quay 1959; NCSM files). Vouchers = NCSM 28640, 28743.

Hyla squirella: The Squirrel Treefrog's range extends into SE Virginia on the mainland (Tobey 1985), but the species is not recorded north of NHWEP on the Outer Banks. This frog was heard calling during the 1987 survey, but no specimens were caught. Voucher specimens exist for Bodie Island and Nags Head; however, none are recorded for NHWEP. Although this species is widespread on the Outer

Table 3. Amphibians and reptiles recorded only in the vicinity of Nags Head Woods on the Outer Banks north of Cape Lookout.

Scientific name	Common name
Amphibians:	
*Acris g. gryllus**	Southern Cricket Frog
Ambystoma opacum†	Marbled Salamander
Bufo quercicus	Oak Toad
Hyla chrysoscelis	Cope's Gray Treefrog
Notophthalmus v. viridescens	Red-spotted Newt
*Plethodon cinereus**†	Redback Salamander
Rana clamitans†	Green Frog
Scaphiopus h. holbrooki	Eastern Spadefoot Toad
Reptiles:	
*Anolis carolinensis**	Green Anole
Carphophis a. amoenus†	Eastern Worm Snake
*Cemophora coccinea copei**	Northern Scarlet Snake
Deirochelys r. reticularia	Eastern Chicken Turtle
Diadophis p. punctatus†	Southern Ringneck Snake
Nerodia e. erythrogaster†	Redbelly Water Snake
Pseudemys r. rubriventris	Redbelly Turtle
Rhadinaea flavilata	Pine Woods Snake
Seminatrix pygaea paludis†	Carolina Swamp Snake
Terrapene c. caroline	Eastern Box Turtle

* Also recorded in the vicinity of Kitty Hawk.
† Not previously recorded from barrier islands (Gibbons and Coker 1978; Gibbons and Harrison 1981).

Banks south of NHW (Quay 1959; NCSM files), its distribution on the northern Outer Banks needs more study. Voucher = Needed.

Notophthalmus viridescens: The NHWEP freshwater habitats would seem to be optimum for supporting a large population of the Eastern Newt. However, inexpli-

Table 4. List of species of amphibians and reptiles widespread on the Outer Banks north of Cape Lookout.

Scientific name	Common name
Amphibians:	
Bufo woodhousii fowleri	Fowler's Toad
Hyla cinerea	Green Treefrog
Hyla squirella	Squirrel Treefrog
Rana utricularia	Southern Leopard Frog
Reptiles:	
Chelydra s. serpentina	Common Snapping Turtle
Cnemidophorus s. sexlineatus	Six-lined Racerunner
Coluber constrictor	Black Racer
Elaphe g. guttata	Corn Snake
Eumeces inexpectatus	Southeastern Five-lined Skink
Heterodon platyrhinos	Eastern Hognose Snake
Kinosternon s. subrubrum	Eastern Mud Turtle
Lampropeltis getulus ssp.	Common Kingsnake
Nerodia sipedon ssp.	Northern Water Snake
Opheodrys aestivus	Rough Green Snake
Ophisaurus ventralis	Eastern Glass Lizard
Storeria dekayi	Brown Snake
Trachemys s. scripta	Yellowbelly Slider

cably, they do not appear to be abundant. The 1986 drought may have depressed the population. But, too few past records exist to judge former population levels. The NHW population probably is referable to the subspecies *N. v. viridescens* (Red-spotted Newt), but more specimens are needed before that can be stated with certainty. This species is not known from the Outer Banks south of Nags Head. Voucher = NCSM 28435; RC.

Plethodon cinereus: The Redback Salamander is recorded from the Outer Banks only in NHW and near Kitty Hawk. This woodland salamander does not use the freshwater ponds for breeding, but does rely on the mainland-like forest for suitable habitat. The 1987 survey efforts were not timed properly to assess the abundance of this salamander. It is most active near the surface when moisture and temperature conditions are favorable (Heathwoe 1962). Such favorable conditions should occur in NHW during wet periods in the spring and fall. However, past collecting efforts and observations of TNC personnel (pers. commun., H. List) support characterizing it as common to abundant in NHWEP. Both the redback and leadback color phases are represented in the local population. Vouchers = NCSM 19054(9).

Rana catesbeiana: The Bull Frog occurs in many of the freshwater ponds in NHWEP, and probably breeds in most of those that do not routinely dry up during years with "normal" precipitation. Although common in NHWEP, this species is not widely distributed on the Outer Banks. They probably depend on the protection from harsh coastal conditions provided by the forest and extensive freshwater habitats. Vouchers = NCSM 24716 (38 larvae), 24733 (2 larvae), 24718–19 (1 adult and 1 larva), 28443 (larva), 28638.

Rana clamitans: Current records indicate the Green Frog occurs nowhere on the Outer Banks except in NHWEP. It seems to be common on the preserve and is recorded from ponds 8, 9, 19, and the 28 complex. Seventeen captures were recorded in the two drift fences. The NHWEP population may be a relict that continues to survive as a result of the protection provided by the mainland-like forest and extensive freshwater pond system. This population has not been compared to the mainland population. Vouchers = NCSM 20389, 28448 (3 larvae).

Rana utricularia: The Southern Leopard Frog is the most abundant frog in NHWEP. They seem to be well adapted to transient and permanent water conditions, and will breed anytime there is a large influx of new water. This species is widespread on the Outer Banks (Quay 1959; NCSM files). Vouchers = DU A4445(3); NCSM 19051–52(2), 28437 (3 larvae), 28441 (1 larva), 28442, 28446 (5 larvae), 28639, 28653 (7 larvae).

Scaphiopus h. holbrooki: Numerous small tadpoles of the Eastern Spadefoot Toad were observed in a ditch at the eastern boundary of NHWEP on 12 April 1987, but were not collected. To what extent this species may extend its range into the mature forest or use the freshwater ponds in NHWEP is not currently known. The Eastern Spadefoot Toad is not recorded elsewhere on the Outer Banks north of Cape Lookout, and a voucher specimen is needed to properly document the Nags Head population. Voucher = Needed.

Reptiles occurring in NHWEP

Agkistrodon p. piscivorus: The Eastern Cottonmouth occurs around most NHWEP ponds. The 1987 population seemed to be smaller than in past years (pers. commun., Henrietta List and Frank Schwartz). Although still present in the area, observations during 1987 suggested this species was not "abundant". Possibly the severe drought conditions during 1986 contributed to a reduced population size. Brothers (1965) reported the species from NHW. Vouchers = RC (2); CM 22883–84(2), 22939–43(5), 23199; DU R1654–56(3).

Anolis carolinensis: The Green Anole is common, is frequently found in vegetation around clearings and along trails, and is regularly seen on buildings and fences. This lizard will occasionally venture out of the maritime forest into the scrub community behind the primary beach dunes. The population in the Nags Head/Kitty Hawk vicinity is at the northeastern limit of the species' range (Conant 1975; Martof *et al.* 1980), and is the only recorded population on the Outer Banks north of Cape Lookout. Brothers (1965) reported the species from NHW. Vouchers = NCSM 19069; CM 23597–98(2); RC(2).

Carphophis amoenus: Three individuals of the Eastern Worm Snake were encountered during the 1987 NHWEP survey. They represent the first specimens from the Outer Banks. This species is undoubtedly dependent on the NHW forest community that offers some protection from the harsh maritime weather conditions. The NHW population would have to be considered disjunct from the mainland population. Voucher = NCSM 28627.

Cemophora coccinea: The Scarlet Snake is a common, although seldom encountered, NHWEP species. It is fossorial and most likely found while crossing roads at night. The population in the Nags Head vicinity is unique in the Outer Banks north of Cape Lookout and appears to be disjunct from the main body of the species' range on the mainland. Martof *et al.* (1980) depicted the species' range to include NHW. Voucher = NCSM 9224.

Chelydra s. serpentina: The Common Snapping Turtle is a wide ranging species that undoubtedly occurs in all of the larger ponds. It is somewhat tolerant of brackish water and has a wide distribution on the Outer Banks (Engels 1942; Quay 1959; NCSM files). Vouchers = NCSM 19061, 28635; ALB 6288.

Cnemidophorus sexlineatus: The Six-lined Racerunner is well adapted to open habitats and appears to be common in the open, sand dune habitat along the east side of NHWEP. More survey work is needed to determine the true status of this species in the preserve. It is a wide ranging and locally common species on the Outer Banks (Engels 1942; Quay 1959; NCSM files). Voucher = DU R1660.

Coluber constrictor: The Black Racer is the most commonly encountered terrestrial snake in NHWEP. Although they prefer forest borders and open, grassy habitats with occasional bushes, they frequently occur in mature forest habitats. Tolerance of the harsh coastal climate and a varied diet permit this species to occur widely on the Outer Banks. Vouchers = RC; CM 22885; DU R1656-57(2).

Crotalus horridus: An apparently small and seldom encountered population of the Timber Rattlesnake occurs in NHW. This species typically requires large wooded tracts of land to survive human depredation. The ever encroaching development that is reducing the size of the "undisturbed" portion of NHW is a serious threat to the continued existence of this species in the area. The species was most recently observed in NHWEP on 17 June 1987. Vouchers = 2 photos of NHWEP specimens in NCSM files.

Deirochelys r. reticularia: The collection of two Eastern Chicken Turtles from NHWEP is a new find on the Outer Banks. However, a disjunct population of this typically southern species occurs in southeastern Virginia (Rageot 1968; Zug and Schwartz 1971), and more survey work is needed to determine if, via Currituck Banks, the NHW population is connected with the Virginia population. The freshwater ponds in NHW would seem to be good habitat for this species. Vouchers = NCSM 28439, 28634.

Diadophis p. punctatus: The Southern Ringneck Snake, like the Eastern Worm Snake, is a new discovery for the Outer Banks. Four individuals collected in 1987 represent the first documented records in NHWEP. This species typically occurs in hardwood and mixed pine/hardwood forests, and is dependent on the extensive forest in NHW for protection from the harsh coastal climate. This population probably is disjunct from the mainland population. Voucher = NCSM 28637.

Elaphe obsoleta: Four individuals of the Rat Snake caught during 1987 in NHWEP represent the first recorded for NHW. Judging from the color patterns exhibited by these specimens, the local population is intermediate between the Yellow Rat Snake (*E. o. quadrivittata*) that occurs to the south and the Black Rat Snake (*E. o. obsoleta*) that occurs to the north (Braswell 1977). NHWEP specimens varied individually from distinctly dark-striped with a light greenish-gray ground color to faintly striped and with dark blotches on a dark gray ground color. Outer Banks populations of this species seem to be dependent on the larger tracts of maritime forest for their survival. Vouchers = NCSM 28591–92(2).

Eumeces inexpectatus: The Southeastern Five-lined Skink is the common, blue-tailed lizard seen in the maritime forest and around the Visitor Center in NHWEP. They occasionally venture into the scrub vegetation behind the primary beach dunes, but are most common in and around forest habitats. This species is widespread on the Outer Banks (Quay 1959; NCSM files). Vouchers = NCSM 15126–27(2), 28741.

Farancia e. erytrogramma: The Rainbow Snake is an uncommon species (or at least seldom found) on the Outer Banks. It is a secretive species of swamps, marshes, and coastal streams, where it is reported to feed primarily on eels. One specimen collected in NHWEP Pond 8 and two additional specimens at Duke University (DU R121 and R2953) demonstrate the species' occurrence from the vicinity of Duck, NC to NHWEP. Voucher = NCSM 28647.

Heterodon platyrhinos: The Eastern Hognose Snake is widely distributed on the Outer Banks (Quay 1959; NCSM files). This species feeds primarily on toads and seems to occur in most places harboring a good food supply. Although it was not encountered during the study, seven records exist in the vicinity of NHWEP, and the snake is probably common in NHW. Vouchers = NCSM 19059–60(2).

Kinosternon s. subrubrum: The Eastern Mud Turtle appears to be common in the freshwater ponds. The NHWEP population is unusually patterned: the head has light stripes somewhat like the Stinkpot (*Sternotherus odoratus*). Currently, NHWEP specimens have not been compared to other Outer Banks specimens or examined for other characters that may differ from mainland specimens. Individuals collected during this survey represent the first documented in NHWEP. Vouchers = NCSM 28632, 28633, 28745 (shell).

Lampropeltis g. getulus: The Eastern Kingsnake is present in NHWEP, but the current records suggest it is uncommon. One individual was sighted on the preserve and one was collected just off the preserve during 1987. Some individuals in the NHW population may exhibit characteristics associated with the Outer Banks Kingsnake (*L. g. sticticeps*) that occurs farther south along the Outer Banks (Lazell and Musick 1973). More specimens from the Nags Head/Kitty Hawk area need to be examined. Voucher = Needed; NCSM 28646 (near preserve).

Nerodia e. erythrogaster: The Redbelly Water Snake occurs in and around the freshwater ponds, but, like the Cottonmouth, it may have been reduced in numbers by the severe 1986 drought. Only two individuals were encountered in NHWEP during 1987. This species is not known to occur elsewhere on the Outer Banks. Vouchers = NCSM 15124; RC; USNM 241618-21 (4 neonates).

Opheodrys aestivus: The Rough Green Snake is widespread on the Outer Banks (Engels 1942; Quay 1959; NCSM files) and probably is common in NHWEP. The vegetation around the freshwater ponds and the ecotone between forest and sound on the west side of the preserve appear to be good habitats for this species. Two individuals were collected (1 released) in NHWEP during 1987. Voucher = NCSM 28963.

Ophisaurus ventralis: The Eastern Glass Lizard is a common species in forest gaps in NHWEP. They are also found in scrub and grassy areas between the forest and the primary beach dunes. The population in the Nags Head area is at the northeastern limit of the species range (Martof *et al.* 1980); only one more northerly specimen has been reported in False Cape State Park, Virginia Beach, VA (Pague *et al.* 1983). Vouchers = NCSM 28492; RC.

Pseudemys r. rubriventris: The Redbelly Turtle is common in the freshwater ponds, and is likely the second most common turtle in NHWEP. The population is difficult to assess, however, because this species is hard to capture in baited traps. The population in NHW is the only one recorded for the Outer Banks. Distinguishing the Redbelly Turtle from the Florida Cooter (*P. f. floridana*) and the Eastern River Cooter (*P. c. concinna*) is difficult. Research on this problem is underway and the NHW population may play an important role in resolving this issue. Vouchers = NCSM 19056 (shell), 19057 (shell), 28658, 28659, 28751 (shell), 28876 (shell), 28877 (shell), 28878 (shell and partial skeleton).

Rhadinaea flavilata: An apparent disjunct, relict population of the Pine Woods Snake is present in the Nags Head Woods area (Palmer and Stephan 1972) and is documented in NHWEP. This species is not recorded elsewhere on the Outer Banks north of Cape Lookout, and the closest mainland record is in Pamlico County, 6.4 km south of Arapahoe. The extensive forest and abundance of prey are key factors in allowing the Pine Woods Snake to survive in the area. Although this snake does not seem to be rare in NHWEP, too little information is available to accurately assess its abundance at this time. Vouchers = NCSM 9346-47(2), 28703.

Scincella lateralis: The Ground Skink is commonly encountered in NHWEP. A slight rustle in the leaves frequently indicates that one is nearby. This species is known to occur in the NHW area and the Buxton Woods area (Quay 1959) on the Outer Banks north of Cape Lookout. The large woods probably help protect this small, fragile lizard from the harsh coastal climate. Ground Skinks occasionally venture out of the mature forests into the surrounding areas of dense scrub vegetation. Vouchers = NCSM 19063, 28649; RC.

Seminatrix pygaea paludis: The Carolina Swamp Snake was a surprise discovery during the 1987 study. One caught in a drift fence near pond 28.3 is the first recorded for the Outer Banks and represents a slight northern range extension for the species [19.3 km NE nearest record (AMNH 102487) from mainland Dare County]. A disjunct population of unknown size obviously resides in the NHWEP area, and ranks with other primarily mainland species as a special feature of NHW. Voucher = NCSM 28680.

Storeria dekayi: The Brown Snake was first discovered in NHWEP during the

1987 survey. It appears to be fairly common (eight drift fence captures were recorded) and is widespread in other areas on the Outer Banks (Quay 1959; NCSM files). The subspecies of the Brown Snake are not clearly defined in North Carolina; much of the state is in an apparent zone of intergradation (Conant 1975). Voucher = NCSM 28681.

Terrapene c. carolina: A population of the Eastern Box Turtle was first documented in NHW during the 1987 survey with three individuals being captured. In addition, Samuel Cooper (pers. commun.) reported sighting at least three separate individuals in NHWEP during 1987. This information combined with reports of previous sightings by TNC personnel (pers. commun., H. List) strongly suggest the presence of a resident, reproducing population. This woodland species is dependent on the heavily forested areas on the Outer Banks and is not expected to reside in other Outer Banks habitats. Voucher = NCSM 28679.

Thamnophis s. sauritus: Although the Eastern Ribbon Snake appears to be uncommon in NHWEP (two captures during 1987), it may in fact be common. This species frequents grassy pond borders and marshlands where its stripes blend very well with background shadows, making the snake difficult to see. Its swift movements also make it difficult to capture, if seen. More observations are needed to determine the true status of the Eastern Ribbon Snake in NHW. This snake also occurs in the Buxton and Hatteras areas on the Outer Banks (Quay 1959, NCSM files). Vouchers = RC(2); NCSM 28682.

Trachemys s. scripta: The Yellowbelly Slider is by far the most common turtle in the freshwater ponds in NHWEP. Five days of turtle trapping resulted in the capture of 91 Yellowbelly Sliders. They are frequently seen away from the ponds on egg laying forays during late spring and summer. Although the 1986 drought may have caused a reduction in this species' population size (judging from the many shells found during 1987), the overall population in NHWEP is in excellent condition. The turtles in most ponds exhibited a range of ages, indicating good recruitment into the population. This species is widespread and common on the Outer Banks (Quay 1959; NCSM files). Vouchers = DU R1662; NCSM 19062, 28444 (shell), 28628 (shell), 28630–31(2), 28746 (shell), 28749–50 (2 shells), 28872 (4 hatchlings).

Amphibians and Reptiles that probably occur in NHWEP

Bufo quercicus: The Oak Toad was recorded from ponds in the vicinity of the Nags Head water tower in 1979. The presence of the Oak Toad on NHWEP seems likely. The Nags Head records represent the only known documented site on the Outer Banks north of Cape Lookout. Vouchers = NCSM 20124, 20125–26(2).

Elaphe g. guttata: Several Bodie Island specimens of the Corn Snake are present in collections. One was collected between NHWEP and the Wright Memorial Monument. Good habitat exists in NHW and it would seem to be just a matter of time before it is documented on the preserve. It is widespread on the Outer Banks between Kitty Hawk and Hatteras (Brothers 1965; NCSM files). Voucher = RC.

Farancia a. abacura: Brothers (1965) reported a specimen of the Eastern Mud Snake from Bodie Island, 0.8 km east of Currituck Sound bridge. The close proximity of this site to NHWEP and the apparently suitable habitat for this species on the preserve make its occurrence there likely. Voucher = RC.

Malaclemys terrapin: The Diamondback Terrapin is common in the brackish sounds along most of the North Carolina coastline. A specimen caught south of Whalebone on Bodie Island seems to be the closest documented record to NHWEP. This species should occur in the brackish sound waters along the western edge of the preserve. Voucher = NCSM 20813.

Nerodia sipedon: A specimen in the Duke University collection from Nags Head, "opposite Coast Guard Station", may be the closest documented site to NHWEP for this species. The Bodie Island population of this species is important from a taxonomic viewpoint because it may be intermediate between the Northern Water Snake (*N. s. sipedon*) and the Carolina Salt Marsh Snake (*N. s. williamengelsi*), and could shed some light on the evolution of the latter subspecies. The brackish sound waters and the freshwater ponds offer good potential for this species to occur in NHWEP. Voucher = DU R884.

Siren lacertina: C. S. Brimley (1915) reported this species from "Collington's Island", but no voucher has been found. It should occur in fresh to slightly brackish waters along the western edge of the preserve.

Other species that might reasonably be expected to occur in NHWEP are *Amphiuma means, Clemmys guttata, Hyla crucifer, Hyla femoralis, Nerodia taxispilota,* and *Thamnophis sirtalis.* Brothers (1965) reported a *N. taxispilota* from ". . . 2.4 miles [3.9 km] S Paul Gamiel's Hill Coast Guard Station 171 . . ."; however, no other specimens of this large and easily observed species have been reported from Bodie Island.

DISCUSSION

Nags Head Woods Ecological Preserve and Nags Head Woods, of which the preserve is a part, support the most diverse amphibian and reptile community documented on the Outer Banks of North Carolina. A total of 41 species are known to occur in NHWEP, and that number will increase if species suspected to occur there are found. Five additional nonmarine species (*Bufo quercicus, Elaphe guttata, Farancia abacura, Nerodia sipedon,* and *Nerodia taxispilota*) documented from the NHW vicinity raise the Bodie Island total to 46. This assemblage is substantially larger than the 27 species reported by Quay (1959) on Cape Hatteras, the 10 species reported for Ocracoke Island (Engels 1942), and the 17 species listed in Table 4 as widespread on the Outer Banks. The amphibian and reptile diversity in the NHW area on Bodie Island (17 families and 46 species) approximates that of mainland Dare County (12 families and 48 species) (NCSM files), and rivals that of the City of Virginia Beach [formerly Princess Anne County, VA] (19 families and 57 species) (Tobey 1985). Eight NHW area species listed in Table 3 plus three other Bodie Island species (*Farancia abacura, Farancia erytrogramma,* and *Rana catesbeiana*) were considered mainland species by Gibbons and Coker (1978). *Terrapene carolina* was subsequently found on Kiawah Island (Gibbons and Harrison 1981).

The obvious question that comes to mind is 'Why are there so many amphibians and reptiles in NHW?' The answer lies in the geologic history and geographic location of the area, in the relative stability of habitats over time (Burney and Burney 1987), in the present diversity of habitats, in the size of the NHW area, in the past and present distributions of the species in question, and in the abilities of those species to colonize new areas. The geologic history and stability of habitats over time in the NHW area probably are best examined by geologists (Pilkey *et al.* 1978) and paleontologists (Burney and Burney 1987), with assistance from historians (Stick 1958). The effect of area size in island systems is a major factor governing species diversity (Darlington 1957; MacArthur and Wilson 1967). Ecologists and taxonomists are well suited to examine the current habitat and species diversity. Clues to past distributions of species can be found by examining natural fossil beds, archaeological sites, and present-day disjunct ranges.

Habitats present in NHW include those routinely present on the Outer Banks (e.g. open grassy areas, open dune communities, scrub communities, and live oak dominated maritime forest), and many additional habitats (e.g. pine flatwoods, mixed pine/hardwood and hardwood forests, and many freshwater pond community types) (Burney and Burney 1987, and references contained therein). These additional habitats provide for more diversity of animals at all trophic levels. Some protection from salt spray and other elements of the relatively harsh coastal environment is accomplished by a number of factors, including depth and density of the woods, sheltered areas resulting from the forested dunes, width of the island, and scrub communities and dunes surrounding the woods. Anything acting to reduce, eliminate, or destabilize the buffering systems in and around NHW have the potential for adversely affecting the plant and animal communities living there. The reason for reduced species diversity on the Outer Banks in general is the result of a reduction in habitat diversity, the relatively small size of the habitats, the isolation of the area, and the failure of some species to cope with the relatively harsh environmental conditions.

The role of the NHWEP freshwater habitats in maintaining the herpetological diversity in the NHW area can, be assessed, in part, by noting the species dependent upon those habitats. Of the 41 species known from NHWEP, 23 are directly associated with the freshwater ponds. Of the 18 species unique to the NHW area on the Outer Banks (Table 3), 11 are directly associated with the freshwater ponds. Other species are indirectly dependent upon these habitats through food web connections that link them to freshwater dependent species (Moler and Franz 1987).

The most noteworthy amphibians and reptiles occurring in NHW fall into one or more of four categories: (1) species generally associated with the mainland and mainland-like habitats; (2) species with disjunct/relict distributional patterns; (3) species at the periphery of their range; and (4) species with taxonomic problems that may be solved in part by studying the local population. All the species occurring in NHWEP, other than those listed in Table 4 as widespread on the Outer Banks, should be considered mainland forms. Also, the terrestrial species occurring in NHWEP that are not widespread on the Outer Banks can be considered more or less disjunct from the main body of the individual species' range, depending on the ability of that species to traverse hostile territory by natural or human assisted means. *Ambystoma opacum, Anolis carolinensis, Carphophis amoenus, Deirochelys reticularia, Diadophis punctatus, Hyla chrysoscelis, Plethodon cinereus, Rhadinaea flavilata,* and *Seminatrix pygaea* are species whose NHW populations are disjunct and probably relicts. These species are unlikely to make contact with populations in the main body of their range because of their inability to traverse the natural barriers of water and inhospitable terrestrial habitats. No population is known from the immediately adjacent mainland for *Deirochelys reticularia* and *Rhadinaea flavilata.* Although *Seminatrix pygaea* is aquatic and could possibly make contact with the mainland to the north, no population of this species is known north of NHW. Other species listed in Table 3 as unique to the NHW area may not usually have genetic exchange with their mainland counterparts, but such exchange seems possible via aquatic or terrestrial pathways now in existence.

The classical concept of island biogeography (MacArthur and Wilson 1967) views islands not only as isolated patches of land surrounded by water, but also as isolated segments of habitat surrounded by other habitat(s) of a different nature. Prior to the closing of the last inlet separating Bodie Island from the mainland around 1828 (Dolan and Lins 1986; Fisher 1962) NHW was an "island" of mainland-like habitat situated on a barrier island. The closing of all inlets north of Oregon Inlet converted the northern segment of the Outer Banks into a long peninsula. The resulting desalination of Currituck Sound had a major impact on its fauna and flora (Weiland 1897). This event opened both terrestrial and aquatic pathways to the NHW area not previously available during historic times. To what extent these routes have been or are being used by any species is unknown. Currituck Sound is virtually fresh with salinities usually less than 3 ppt (Winslow 1983) during normal weather conditions, and it supports an abundance of predominately freshwater fish species (Crowell 1968).

The biogeographic implications of the herpetofauna in NHW appear complex. More information will have to be gathered before final conclusions are made. Comparing NHW herpetofaunal diversity to barrier island diversity reported elsewhere (Blaney 1971; Engels 1942, 1952; Gibbons and Coker 1978; Gibbons and Harrison 1981; Hillestad *et al.* 1975; Lee 1972; Lewis 1946; Martof 1963; Parnell and Adams 1970; Quay 1959) is difficult and could be misleading. Sampling efforts and techniques varied greatly between the studies. Also, the NHW area is not located on an island at the present time.

Populations at the periphery of a species' range are important from an ecological and evolutionary standpoint because they may be in closest contact with ecological factors that limit the species' distribution. Species in NHWEP that are at or very near the periphery of their ranges include: *Anolis carolinensis, Deirochelys reticularia, Ophisaurus ventralis, Pseudemys rubriventris, Rhadinaea flavilata,* and *Seminatrix pygaea.* Three of these species are at the northeastern limit of their ranges at NHW: *A. carolinensis, O. ventralis,* and *S. pygaea.* The main ranges of *D. reticularia* and *R. flavilata* lie to the south, and the NHW populations represent relict fragments of ranges that used to be more extensive. The NHW population of *P. rubriventris* is near the southern limit of that species' range, as currently defined. Moreover, an unresolved taxonomic problem exists involving *P. rubriventris, P. floridana* (Florida Cooter), and *P. concinna* (River Cooter), and the ranges of at least two of these species meet in coastal North Carolina near NHW.

Species occurring in NHWEP that are most likely aided in their distributions by human activities include *Hyla squirella, Hyla cinerea, Terrapene carolina, Anolis carolinensis,* and *Trachemys scripta.* Of these, only *T. carolina* and *A. carolinensis* are not widespread on the Outer Banks. But the likelihood of both species occurring naturally in NHW seems good.

As NHW shrinks because of encroaching development, populations of many species will also be reduced. The amount of reduction the various populations can withstand and still remain viable is unknown. *Crotalus horridus,* which requires relatively large forested tracts to survive human persecution, probably will be the first to disappear.

The drought NHW experienced in 1986 was the worst in approximately 40 yr, based on information from longtime residents and rainfall data (pers. commun., TNC). The drought's effect on the amphibian and reptile populations in NHW is still largely unknown. The number of turtle shells (*Trachemys* and *Pseudemys*) found around the freshwater ponds during the year following the drought was larger than usual (pers. commun., TNC). However, the populations of these two species appear healthy and must not have been impacted to any great extent. Recollections of past population levels of aquatic snakes (*Agkistrodon piscivorus* and *Nerodia* spp.) by TNC personnel and other researchers suggest a significant reduction in numbers for these species. Frank Schwartz (pers. commun.) surveyed fish populations in most NHWEP ponds in 1983 and again in 1987, and stated that the numbers of *Agkistrodon piscivorus* and *Nerodia erythrogaster* were drastically down in 1987 from those observed in 1983. Searches by NCSM personnel in ponds where Cottonmouths were supposed to be abundant produced no more than one live snake on any given occasion, and only two Redbelly Water Snakes were recorded during the entire study period. Given the amount of freshwater habitat available, there seems to be a shortage of members of these two genera. One could speculate that the drought conditions reduced the food supply for the snakes and may have exposed them to increased predation. Unfortunately, no size estimates or capture success rates exist for any amphibian or reptile population in NHW or NHWEP prior to the drought. Therefore, damage to species, other than extirpation, can only be guessed at, and no species is known to have been eliminated from the area. While probably damaging to some species, the drying out of the ponds likely helped others by allowing the pond substrates to be oxygenated, thus increasing productivity after they refilled with water (Odum 1959).

The sampling effort expended during the study period added greatly to the knowledge of the amphibians and reptiles in NHWEP. Other habitats need to be sampled using drift fences to obtain quantitative data on species abundance, and to better understand which species depend on which habitats. A more complete survey of amphibian breeding sites is needed to help judge the importance of specific ponds and pond habitats. Aquatic turtle sampling should be done with traps designed to catch species not easily baited into standard turtle hoop nets. Also, mark and recapture of turtles could provide population size estimates that might be useful in the future when judging the health of the freshwater ponds. Herpetological survey work should be done in the plant communities bordering the sound on the west side of NHWEP. That area received very little attention during this survey.

Management practices should be established to protect the unique aspects of Nags Head Woods so they can be studied, understood, and appreciated by present and future generations. Probably the best management tool available for all the species in NHW is simply to maintain the area in as near to its natural state as feasible. To this end, efforts should be made to acquire and maintain in its natural state as much of the remaining parts of Nags Head Woods as possible. The rapid development in the area cannot be stopped; therefore, additional aquisitions to enlarge the existing preserve are important. Also, any introductions into the area should be considered carefully in an effort to protect unique gene pools that may exist in local populations.

The possibility of monitoring the size and health of some populations of amphibians and reptiles in NHWEP is realistic only if the time, expertise, and money are available. The more abundant and easily captured species are the best candidates for such studies. *Ambystoma opacum* and *Trachemys scripta* are two of the best possibilities because of their predictability, abundance, and ease of capture when using proper equipment and technique. Frequently, all that can be established for species that cannot be captured in relatively large numbers is presence or absence in a given location or habitat. That is important, particularly for unique species in the area, but it is difficult to use them to predict population trends. Species whose availability is tied more to short term climatic events than to seasons of the year can be monitored if someone is always there to catch them in-the-act.

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BREEDING BIRDS OF NAGS HEAD WOODS, DARE COUNTY, NORTH CAROLINA

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ABSTRACT

Nags Head Woods, Dare County, found along the Outer Banks of North Carolina, is an isolated patch of maritime forest on a narrow barrier island. The woods, dominated by *Pinus taeda, Carya ovalis, Liquidambar styraciflua, Quercus falcata,* and *Nyssa sylvatica,* are uncharacteristic of North Carolina's barrier islands. Most maritime forests along the Outer Banks are dominated by *Quercus virginiana, P. taeda,* and *Juniperus virginiana* (Godfrey and Godfrey 1976). During May and June of 1986 and 1987, breeding bird surveys were conducted to determine avian diversity, relative density, and habitat associations. Using a modified strip-map method (Emlen 1984), 46 species with a mean of 115.1 birds per hour were found within Nags Head Woods. Species richness was highest in the *P. taeda* community. Avian abundance was greatest in the *L. styraciflua* and *N. sylvatica* forests. The Carolina Wren was the most frequently encountered bird. A list of species with relative abundance is presented by major community type.

INTRODUCTION

While the Outer Banks of North Carolina are well known for attracting large numbers and species of migrant and winter birds, no detailed quantitative information is available concerning the summer or breeding avifauna along these islands, particularly within woodland communities. Woodlands represent the most stable upland communities on these islands and offer a unique opportunity to study breeding birds within a limited habitat.

STUDY AREA

Nags Head Woods, centered on coordinates 35°59′50″N and 75°40′W, is one of the largest surviving stands of maritime forest on the Outer Banks. A well developed, stabilized back barrier dune field has provided the necessary protection to permit the development of an unusually mature maritime forest. The diversity and complexity of these vegetative communities has created a forest uncharacteristic of barrier islands. The woods comprise over 600 ha and are about 12 km from the nearest mainland. The topography is characterized by high, steeply sloped forested ridges, over 27 m in elevation, and alternating depressions, some filled with permanent freshwater ponds.

The vegetation of Nags Head Woods is dominated by a mixture of pine, oak-hickory, and sweetgum-tupelo gum forests. More than nine forest communities have been described within Nags Head Woods (Otte *et al.* 1984, 1985 unpublished; Ecological Inventory reports to North Carolina Nature Conservancy, 58 and 103 p. respectively unpublished). Four forest-type communities: mixed hardwoods, pine flats, gum forests, and bay forest were surveyed as were two additional animal related habitats, edge and overhead. Quantitative and qualitative sampling of vegetation was performed for the analysis of bird-habitat relationships (Cooper, in prep.). Generalized descriptions are presented for each community surveyed.

The forested dunes contain the most mature communities within the woods. Well drained, sand based soils support a mixed pine and hardwood forest (Otte *et al.* unpublished 1985). Dominated by a mixture of more mesic species, the major canopy species are *C. ovalis, P. taeda, Cornus florida, Q. falcata,* and *Quercus laurafolia.* Dominant subcanopy species include *Ilex opaca, Ostrya virginiana,* and *C. ovalis.*

The forested interdunal flats contain two major community types: pine flats and sweetgum-tupelo gum forests. Topographically lower than forested dunes, the water table is much closer to the surface. Sand based soils often become hydric at lower elevations within the tupelo gum forests (Otte *et al.* unpublished 1985). Winter flooding is common in the sweetgum-tupelo gum forests and some permanently standing water is often present in the lowest depressions. The canopy is dominated by mixtures of *L. styraciflua, N. sylvatica, Acer rubrum,* and *Persea borbonia.* Subcanopy species consist of the canopy species.

Dry interdunal areas support pine woodlands dominated by *P. taeda.* Although pure stands of *P. taeda* are present, slight changes in relief often create intergrades of pine flats with adjacent communities. Major subcanopy species include *A. rubrum, C. florida, I. opaca,* and *Sassafras albidum.*

Bay forest areas form a narrow band of wetlands between the western edge of the dune field and the eastern edge of a brackish marsh. Soils are mostly hydric, saturated to or near the surface, and are organic based (Otte *et al.* unpublished 1985). Occasional areas of higher elevation create hummocks occupied by less flood tolerant species. Canopy species consist largely of *Persea borbonia, L. styraciflua,* and *A. rubrum.* Other species present are *N. sylvatica, Magnolia grandiflora, Magnolia virginiana* and in higher areas both *Quercus nigra* and *P. taeda.* Major subcanopy species consist of canopy species, and *Myrica cerifera.* Unlike other communities, the vegetation of the forest floor is dense and consists of canopy species, *Osmunda cinnamonea,* and *Arundinaria gigantea.*

Two non-forest communities are included in the study. Any large break in the forest canopy is considered an edge community. This includes all open-water ponds, a power-line cut, borrow pit, and roads. Dominant vegetation is similar to that of adjacent communities, but is no higher than the subcanopy level. The overhead community includes avian species flying over the woods that are expected within the woods, but not directly associated with any one particular forest community.

METHODS

The census period extended from early May into mid June of 1986 and 1987 to coincide with the peak nesting period for most avian species in northeastern North Carolina. Avian composition and density were recorded in accordance with Emlen's (1984) method of an observer-specific, strip-map method for censusing songbird communities. The strip-map method involved walking a fixed transect 2.5 km long that extended through a series of habitat types representative of Nags Head Woods.

The transect method was chosen, rather than the more traditional method of quadrant analysis, because of the lack of homogeneous vegetation. The transect method is simply a modified narrow quadrant, with the advantage of less variance in an area of patchy vegetation rather than a rectangular plot or series of plots of the same size (Grieg-Smith 1964).

The width of the transect was the distance at which singing birds were detected by ear on either side of the transect. Because species differ in the distance at which they could be heard, strip widths or areas were different for each species. The complexity and mosaic nature of forest communities resulted in the use of relative abundance as a measure of the population level rather than absolute density.

Surveys began at alternate ends of the transect and were conducted every three days or until 11 surveys were completed for a year. Each census began within 30 min before sunrise and was postponed in the presence of winds greater than 32.2 km/hr or rain.

All singing birds were recorded in reference to listening stations, each 50 m apart. The time of day was recorded at each listening station so that duration of habitat coverage could be noted. Bird detections made at and between each station were recorded with distance from transect and habitat. Observations were timed by habitat to permit an expression of birds per hour for each community surveyed. Temperature, cloud cover, wind speed and direction, and presence of dew was recorded at the beginning of each survey. Habitat preference and relative abundance per habitat were determined for each suspected breeding species.

RESULTS

Comparing the relative abundance patterns of each species in the six major habitats surveyed, the five most abundant species in each community revealed the Carolina Wren the most abundant bird in all woodland communities (Table 1). Considering only the four woodland communities and excluding edge and overhead communities, the Carolina Wren (16.7%), Northern Cardinal (12.5%), Pine Warbler (8.1%), Fish Crow (7.6%), and Common Grackle (7.0%) comprised 51.9% of the breeding avifauna. The five species most regularly encountered in each major community type were termed characteristic species and are described below. The relative abundance of each species was expresssed as its percent of the total fauna in that community. If more than half of the total mean birds per hour for a species was found in one community, then it was listed as a selective species preferring that community.

A total of 31 suspected breeding species were found in association with the pond and edge community. Characteristic species included: Indigo Bunting (18%), Northern Cardinal (16%), Mourning Dove (9%), Common Grackle (9%), and Carolina Wren (7%). Species exhibiting a preference for the community were Mourning Dove, Brown Thrasher, Indigo Bunting, and Blue Grosbeak along the power-line cuts; the Mallard, Wood Duck, Osprey, and Belted Kingfisher on open-water ponds. Eleven species each comprised less than 1% of the community population.

The oak-hickory-pine forest contained 35 species. The Carolina Wren (16%), Pine Warbler (13%), Northern Cardinal (12%), Great Crested Flycatcher (9%), and Fish Crow (10%) were characteristic species. The Chuck-will's-widow showed a preference for this community. Nineteen species each comprised less than 1% of the community population.

The pine flats contained 43 species. The Carolina Wren (16%), Pine Warbler (13%), Northern Cardinal (12%), Fish Crow (10%), and Great Crested Flycatcher (5%) were the most common species. Eastern Screech-owl, Eastern Wood-pewee, Yellow-throated Warbler, and Rufous-sided Towhee preferred this community. Twenty-five species each comprised less than 1% of the community population.

The sweetgum-tupelo forest supported 38 species. The Carolina Wren (14%), Common Grackle (13%), Fish Crow (10%), Northern Cardinal (9%), and Prothonotary Warbler (8%) were characteristic species. Habitat preferential species included: Green-backed Heron, Red-shouldered Hawk, Downy Woodpecker, Acadian Flycatcher, Prothonotary Warbler, Common Yellowthroat, Red-winged Blackbird, Common Grackle, and Summer Tanager. Nineteen species each constituted less than 1% of the community population.

Table 1. Relative abundance indices for breeding birds in Nags Head Woods for 1986 and 1987. Numbers represent mean number of birds per hour for each of the six communities studied.

	Habitat type					
Species	Pond and edge	Hard-woods	Pine flats	Gum forest	Over-head	Bay forest
Green-backed Heron	0.10	0.02	0.04	0.20	0.16	—
Wood Duck	0.21	—	0.06	0.08	0.10	—
Mallard	0.37	—	—	—	0.06	—
Osprey	0.16	—	—	0.04	0.22	—
Red-shouldered Hawk	—	0.22	0.10	0.32	—	—
Northern Bobwhite	0.06	0.06	0.46	—	—	1.00
Mourning Dove	1.05	0.08	0.14	0.08	0.04	0.16
Yellow-billed Cuckoo	—	0.61	0.54	0.86	—	0.28
Eastern Screech Owl	—	0.04	0.06	—	—	—
Chuck-Will's-Widow	—	0.30	0.08	—	—	—
Ruby-throated Hummingbird	0.21	0.16	0.52	0.40	0.04	—
Belted Kingfisher	0.10	—	0.04	0.04	0.02	—
Red-bellied Woodpecker	—	0.06	0.26	0.28	—	0.28
Downy Woodpecker	—	0.02	0.02	0.08	—	—
Northern Flicker	0.21	0.12	0.28	0.47	—	0.16
Pileated Woodpecker	0.06	0.64	0.65	0.75	—	0.28
Eastern Wood-Pewee	—	0.04	0.41	0.04	—	0.16
Acadian Flycatcher	—	0.04	—	0.04	—	—
Great Crested Flycatcher	0.06	1.50	1.40	1.34	0.02	1.28
Eastern Kingbird	0.10	0.12	0.10	0.16	—	—
Blue Jay	—	0.54	0.46	0.20	—	—
American Crow	0.26	1.07	1.37	1.10	0.44	0.88
Fish Crow	0.63	1.37	2.61	3.22	0.74	0.28
Carolina Chickadee	0.06	0.50	0.91	1.22	—	0.44
Carolina Wren	0.89	2.45	4.19	4.62	—	5.13
Blue-gray Gnatcatcher	0.16	0.10	0.60	0.12	—	0.28
Gray Catbird	0.06	—	0.08	0.08	—	0.44
Brown Thrasher	0.10	—	0.06	—	—	—
White-eyed Vireo	0.26	—	0.18	0.04	—	1.28
Red-eyed Vireo	—	0.36	0.22	0.60	—	0.28
Northern Parula	0.16	1.07	0.79	0.91	—	0.72
Yellow-throated Warbler	—	0.08	0.20	0.04	—	—
Pine Warbler	—	1.92	3.52	1.53	—	1.00
Prairie Warbler	0.10	—	0.02	—	—	0.16
Prothonotary Warbler	0.21	0.08	0.34	2.51	—	1.00
Common Yellowthroat	0.06	—	0.02	0.20	—	—
Hooded Warbler	—	0.02	0.14	0.04	—	0.88
Summer Tanager	—	0.22	0.20	1.80	—	0.44
Northern Cardinal	1.93	1.82	3.26	2.83	—	4.41
Blue Grosbeak	0.32	—	0.02	—	—	—
Indigo Bunting	2.15	0.12	0.34	0.51	—	0.44
Rufous-sided Towhee	—	—	0.04	—	—	—
Red-winged Blackbird	0.32	0.02	0.10	0.59	0.10	—
Common Grackle	1.10	0.61	1.11	4.28	2.12	0.88
Brown-headed Cowbird	0.37	0.10	0.47	0.39	0.71	0.44
Orchard Oriole	0.16	0.08	0.12	0.12	—	0.16
Total breeding species	31	35	43	38	13	27
Mean number of birds per census	10.4	38.0	60.9	37.2	10.9	7.3
Approximate number of hours surveyed	19.1	50.6	50.6	25.5	50.6	7.0
Mean number of birds per hour per census	11.99	16.56	26.53	32.13	4.77	23.14

Thirteen species were recorded overhead. Species commonly seen were Common Grackle (44%), Fish Crow (15%), Brown-headed Cowbird (15%), American Crow (9%), and Osprey (5%). Although Barn Swallows and Purple Martins were recorded, no conclusive evidence of nesting within the woods was found. Four species each constituted less than 1% of the community population.

The bay forest contained 27 species. Characteristic species included Carolina Wren (22%), Northern Cardinal (19%), Great Crested Flycatcher (6%), White-eyed Vireo (6%), Prothonotary Warbler (3%), Pine Warbler (3%), and Northern Bobwhite (3%). The Northern Bobwhite, Gray Catbird, White-eyed Vireo, Prairie Warbler, and Hooded Warbler preferred this community. Five species each comprised less than 1% of the community population.

Chimney Swift, Purple Martin, and Barn Swallow were often seen overhead during the study period, but it is unlikely they nest regularly in the woods. American Robin, Wood Thrush, Black-throated Green Warbler, Ovenbird, American Redstart, and American Goldfinch may nest occasionally in the woods. The presence of these species in late May suggests nesting. Since migrants were recorded in late May, and nesting evidence was inconclusive, these species were not listed as breeders.

SUMMARY

Species richness was greatest in the pine flats with 43 species present and lowest in the bay forest where 27 species were found. The sweetgum-tupelo gum forest had the greatest abundance of individuals with a mean of 32.13 birds per hour and the pond and edge community the lowest with 11.99 birds per hour. Considering only five of the most common birds in each woodland community, a similar percentage of community occupancy was found ranging from 54 to 59%. The Carolina Wren was the most common bird with an average of 17.28 birds encountered per hour.

Of the 46 probable breeding species recorded in Nags Head Woods, none are considered rare or restricted to maritime woodlands. The species present are common, wide-ranging, and often found in a variety of habitats. Of the segmented forests found along North Carolina's Outer Banks, Nags Head Woods contains the most breeding species (Cooper, in prep.). It provides one of the last areas of refuge and offers a unique and valuable resource for forest nesting birds along the Outer Banks.

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THE MAMMALS OF NAGS HEAD WOODS ECOLOGICAL PRESERVE AND SURROUNDING AREAS

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ABSTRACT

Nags Head Woods Ecological Preserve (NHWEP) is inhabited by 24 species of mammals, representing the greatest mammalian diversity on the Outer Banks. This diversity is attributable to the relatively large number of habitats found in the Preserve and adjaeent areas, and that Currituck-Bodie Island is connected to the mainland via southeastern Virginia, thereby providing a corridor for dispersal onto the northern Outer Banks. The importance of NHWEP as a reservoir for sylvan-adapted species will increase as other forested habitats are altered to accomodate increased development along the Outer Banks.

INTRODUCTION

The mammalian fauna of North Carolina's Outer Banks is poorly documented save the published checklists provided for Ocracoke Island (Engels 1942), Shackleford Banks (Engels 1952), and anecdotal distributional records for individual species (Adams *et al.* 1987; Engels 1941; Webster *et al.* 1986; Webster *et al.* in press). Lee *et al.* (1983) provided a distributional survey for all mammal species known from North Carolina, but some of the insular records either lack voucher specimens (for example, *Felis rufus*) or did not represent established breeding populations (for example, *Ursus americanus*). Recent mammal surveys at several sites along the coast of North Carolina, namely the Corolla area of Currituck County, Nags Head Woods (NHW) and Buxton Woods in Dare County, Core and Shackleford banks in Carteret County, Bear Island in Onslow County, Masonboro and Ft. Fisher islands in New Hanover County, and Bald Head Island in Brunswick County (see also Adams *et al.* 1987), have been supplemented gratiously by the trapping results of Jim Boone at Bodie Island and the unpublished reports for several islands in southeastern part of the state (Colwell 1983) and Hatteras Island (Quay 1959, unpubl. ms.). This report identifies the mammalian fauna of Nags Head Woods Ecological Preserve (NHWEP), compares it to those found on other barrier islands in the state, and briefly discusses the importance of the Preserve as a reservoir for mammalian diversity.

MATERIALS AND METHODS

A census of the mammalian fauna of NHWEP was conducted between September 1986 and September 1987. Sherman live traps and/or #10 pitfall cans were set in all habitat types within the Preserve, "roadkill" specimens were collected immediately adjacent to the property on U.S. Highway 158, and spoor were identified to validate the presence of species not otherwise collected or observed. In addition, some specimens were collected in the Preserve by larger pitfall traps and associated drift fences set by Alvin Braswell of the North Carolina State Museum of Natural Sciences. Voucher specimens are deposited in The Vertebrate Collections at the University of North Carolina at Wilmington. Where noted the subspecific allocations of these species is tentative; trinomials are from Hall (1981).

CHECKLIST

1. Virginia opossum, *Didelphis virginiana virginiana* Kerr

The opossum is relatively common along the Outer Banks in Currituck and Dare counties as far south as Oregon Inlet, including NHWEP. It is uncommon on Hatteras, Bear, Masonboro, and Bald Head islands.

2. Southern short-tailed shrew, *Blarina carolinensis carolinensis* (Bachman)

The only records of the southern short-tailed shrew along the Outer Banks are from 3.5 km NNW Kitty Hawk and Bodie Island (Webster *et al.* in press); however, it also has been taken on Bald Head Island (Adams *et al.* 1987) and several dredge-material islands along the Atlantic Intracoastal Waterway (AIWW) (Webster *et al.* in press). It probably occurs in small numbers in the marsh and forest at NHWEP.

3. Least shrew, *Cryptotis parva parva* (Say)

This shrew is found in most habitats along the Outer Banks; it is locally abundant in salt and freshwater marshes, but uncommon in thickets, forests, and around freshwater ponds. Specimens are known from NHWEP, where it is relatively common, Bodie Island, Hatteras Island (Quay 1959, unpubl. ms.), Bald Head Island (Adams *et al.* 1987), and several dredge-material islands along the AIWW.

4. Eastern mole, *Scalopus aquaticus* cf. *howelli* Jackson

Moles are abundant in the thickets and forests of NHWEP, as they are in most sylvan habitats with soils that contain relatively high amounts of organic matter, silt, and clay. They are progressively less abundant in swales and grasslands, dunes, and the beach strand. Moles occur on all barrier islands except Core Banks and Ocracoke Island (Engels 1942). Insular moles appear paler and smaller than mainland individuals attributable to *S. a. howelli.*

5. Silver-haired bat, *Lasionycteris noctivagans* (Le Conte)

Only one record for the silver-haired bat exists along the Outer Bank, that being from Hatteras Island (Lee *et al.* 1983). This species probably uses the forests at NHWEP for daytime roosts at irregular intervals during spring and autumnal migrations.

6. Red bat, *Lasiurus borealis borealis* (Müller)

Quay (1959, unpubl. ms.) provided the only record of the red bat on the Outer Banks (Hatteras Island), and I have partial skeletons from owl pellets collected on Bodie Island. This bat is abundant in the Buxton Woods area during fall migrations, and has been sighted at NHWEP as well. It also uses coastal forests for daytime roosts.

7. Marsh rabbit, *Sylvilagus palustris palustris* (Bachman)

The marsh rabbit is a common but elusive denizen of the salt marshes and thickets in NHW; however, it seldom frequents freshwater ponds in dense forests and rarely ventures into open swale and dune habitats. Marsh rabbits occur on all barrier islands examined by me, as well as Ocracoke Island (Engels 1942) and Bogue Banks (Lee *et al.* 1983).

8. Eastern cottontail, *Sylvilagus floridanus mallurus* (Thomas)

The most ubiquitous and abundant rabbit on North Carolina's barrier islands is the eastern cottontail. It was seen most frequently in NHWEP in such man-made ecotonal communities as roadsides, trails, and powerlines, but it was encountered in all Outer Bank habitats and islands examined, including Engels' (1942) report from Ocracoke Island.

9. Eastern gray squirrel, *Sciurus carolinensis carolinensis* Gmelin

This squirrel is found on all barrier islands with suitable habitat, that being forests with ample mast. It is abundant in NHWEP. Gray squirrels are not found on unforested barrier islands such as Masonboro or Core Banks, and Engels (1942) did not record it at Oracoke. Lee *et al.* (1983) provided a record from Bogue Banks.

10. Marsh rice rat, *Oryzomys palustris palustris* (Harlan)

As its name implies, this rat is found in marshes and other wet habitats on every barrier island in North Carolina; however, its abundance diminishes as latitude increases. Marsh rice rats are common in NHW salt marshes, and uncommon in the marsh-forest ecotone. Likewise, it is abundant in the salt marshes of Bald Head, Fort Fisher, Masonboro, and Hatteras islands, but uncommon in the brackish to freshwater marshes of Currituck Sound.

11. Eastern harvest mouse, *Reithrodontomys humulis humulis* (Audubon and Bachman)

The most elusive mouse on North Carolina's barrier islands is the harvest mouse, which has been reported only from Ocracoke (Lee *et al.* 1983) and Bald Head islands (Adams *et al.* 1987). It is rare in swales dominated by dense herbaceous cover near Corolla in Currituck County, and I suspect that in similar habitats it is a rare denizen of NHWEP.

12. White-footed mouse, *Peromyscus leucopus* cf. *easti* Paradiso

The white-footed mouse is common in all woodland habitats along the Outer Banks as far south as Hatteras Island. It is found in NHWEP in hardwood forests, swamps, and around piles of debris. Captured individuals are tentatively allocated to *P. l. easti,* a subspecies named and described on the basis of specimens from Virginia Beach, Virginia. The taxonomy of white-footed mice along the Outer Banks is under investigation by me, as are those of eastern moles, cotton mice, and hispid cotton rats.

13. Hispid cotton rat, *Sigmodon hispidus* cf. *hispidus* Say and Ord

The status of the hispid cotton rat along North Carolina's barrier islands remains enigmatic. Lee *et al.* (1983) recorded it from NHWEP and Hatteras Island, but the Hatteras population (*ca.* Buxton) evidently has been extirpated (Clay Gifford, in litt.). I found characteristic runways, clippings, and droppings near Corolla, but failed to take voucher specimens. Cotton rats are denizens of early successional habitats, such as powerline cuts and roadsides.

14. Meadow vole, *Microtus pennsylvanicus nigrans* Rhoads

The meadow vole has been reported from Currituck-Bodie and Hatteras islands (Lee *et al.* 1983), and it probably occurs in suitable habitat in NHWEP. Specimens are most common in fresh- to saltwater marshes, especially on hummocks. Specimens from Bodie Island are clearly assignable to *M. p. nigrans,* whereas those from Hatteras Island represent *M. p. pennsylvanicus.*

15. Muskrat, *Ondatra zibethicus macrodon* (Merriam)

The most important fur-bearer along the Outer Banks is the muskrat. It occupies freshwater and saltwater marshes as far south as Shackleford Banks (Webster

1987, unpubl. ms.), although Engels (1942) did not record it from Ocracoke Island. Muskrat numbers have been reduced as nutria, a South American rodent introduced at several places along the Atlantic, Gulf, and Pacific coasts as a source of fur, usurps habitats favored by muskrats. Muskrats seldom venture into wooded habitats, but they occasionally utilize the freshwater ponds at NHWEP.

16. Norway rat, *Rattus norvegicus* (Berkenhout)

17. House mouse, *Mus musculus* (Linnaeus)

These commensal rodents were introduced to North America by early settlers, and both species occur on North Carolina's barrier islands. The Norway rat has been reported from Currituck-Bodie (Jim Boone, pers. comm.) and Hatteras (Quay 1959, unpubl. ms.) islands. The house mouse is widespread on all barrier islands in the state except Shackleford Banks, where it has been extirpated (Webster 1987, unpubl. ms.). The Norway rat and house mouse probably inhabit NHWEP, albeit in small numbers.

18. Nutria, *Myocastor coypus bonariensis* (E. Geoffroy St.-Hilaire)

The nutria was introduced to Hatteras village in 1941 (Quay 1959, unpubl. ms.) and has steadily expanded its range southward to Shackleford (Webster *et al.* 1986) and Bogue (Webster 1987, unpubl. ms.) banks, and northward throughout Currituck County and into Virginia. Along the Outer Banks it is uncommon to the south (Bogue and Shackleford banks) but abundant further north (Hatteras and Currituck-Bodie islands, including NHW) in freshwater and saltwater marshes.

19. Gray fox, *Urocyon cinereoargenteus cinereoargenteus* (Schreber)

The gray fox is a common denizen of Currituck-Bodie, Masonboro, Fort Fisher, and Bald Head islands, and it also has been reported from Bogue Banks (Lee *et al.* 1983). Its status on Hatteras Island is uncertain as sight records exist (see, for example, Lee *et al.* 1983; Quay 1959, unpubl. ms.) and most locals have a fox story to tell, but voucher specimens are nonetheless lacking. Although seldom seen, it is relatively common in NHWEP.

20. Raccoon, *Procyon lotor lotor* (Linnaeus)

The most common carnivore on North Carolina's barrier islands is the raccoon. It occupies a wide range of habitats, and is abundant on all islands examined by me, as well as Hatteras Island (Quay 1959, unpubl. ms.). It is abundant in NHWEP.

21. Mink, *Mustela vison mink* Peake and Palisot de Beauvois

Mink are uncommon but widespread on all barrier islands in the state, including NHWEP. Numbers are slightly depressed inasmuch as its favored prey, the muskrat, is less abundant since nutria were introduced to the Outer Banks.

22. River otter, *Lutra canadensis lataxina* F. Cuvier

The river otter is increasing in numbers along the coast of North Carolina; it is relatively common in the marshes of all barrier islands, including NHW, and also has been reported from Bogue Banks (Lee *et al.* 1983).

23. House cat, *Felis catus* Linnaeus

Feral house cats occur on all barrier islands examined during the course of this investigation except Masonboro, and they probably inhabit NHWEP as well. Some control of this locally common pest is recommended.

24. White-tailed deer, *Odocoileus virginianus virginianus* (Zimmermann)

Forests and thickets provide haven for deer, which are locally abundant where adequate cover exists on Currituck-Bodie, Hatteras, and Bald Head islands. Deer also have been observed swimming the AIWW and occupy several islands in the southeastern part of the state (Webster *et al.* 1986). The herd in NHWEP numbers about 40–50 animals.

DISCUSSION

Twenty species of native mammals are recorded from NHWEP or adjacent properties. Not included in this checklist are the southeastern shrew (*Sorex longirostris*), which was reported from Hatteras Island on the basis of material removed from owl pellets (Engels 1941; Lee *et al.* 1983); other species of bats that may use the forest for daytime roosts; chipmunk (*Tamias striatus*), which was reported from coastal islands near Bogue Banks (Coues and Yarrow 1878), but does not occur in that part of the state; cotton mouse (*Peromyscus gossypinus*), which apparently is not distributed on barrier islands further north than Buxton Woods; red fox (*Vulpes vulpes*), which occasionally wanders southward on Currituck-Bodie Island (Parnell *et al.* 1987a, b, unpubl. ms.) from southeastern Virginia; black bear (*Ursus americanus*), which was reported from Bodie Island (Lee *et al.* 1983) on the basis of a specimen that swam from the mainland; or bobcat (*Felis rufus*) which has been recorded from Currituck-Bodie Island (Lee *et al.* 1983) only on the basis of sight records. Bobcat stories are associated with all barrier islands (except Masonboro), and yet I never saw evidence that would support bobcat occurrence on any island, nor are voucher specimens available. Four species of introduced or feral animals inhabit NHWEP; but this does not include the black rat (*Rattus rattus*), which is known from Ocracoke Island (Engels 1942), or horses, cows, pigs, goats, or sheep, which do not occur in NHWEP but inhabit other barrier islands in the state (Webster 1987, unpubl. ms.).

Mammalian diversity on Currituck-Bodie Island is greater than on any other barrier island in North Carolina or adjacent states (Andre 1981; Dueser *et al.* 1979; Johnson *et al.* 1974; Paradiso and Handley 1965; Pelton 1975; Porter and Dueser 1982). This diversity is maintained by three factors: Currituck-Bodie Island is connected to the mainland and therefore serves as a corridor for dispersal from southeastern Virginia; increased habitat diversity, which ranges from fresh- to saltwater marshes and hardwood to evergreen forests, and includes thickets, grasslands (swales), dunes, as well as areas modified by man; and the zoogeographic importance of the Outer Banks as a tension zone between competing pairs of species, such as *Peromyscus leucopus* and *P. gossypinus* or *Sigmodon hispidus* and *Microtus pennsylvanicus*, species which occupy the same relative niche but are separated throughout much of their geographic ranges (*P. leucopus* and *M. pennsylvanicus* to the north and *P. gossypinus* and *S. hispidus* to the south).

Mammalian diversity in NHWEP is slightly impoverished compared to that of the entire island simply because all habitat types are not well represented in the Preserve. However, ample segments of undisturbed habitat (salt marsh, pine forests, hardwood forests, hardwood swamps, and freshwater ponds) in NHWEP contain most of the species listed above. The salt marsh is home to least shrews, marsh rabbits, marsh rice rats, muskrats, nutria, mink, and otter. Forests are occupied by opossums, least shrews, southern short-tailed shrews, eastern moles, at least two species of bats, gray squirrels, white-footed mice, raccoons, and deer. Freshwater ponds are frequented by muskrats, raccoons, otter, and deer, and bats forage over their waters. Ecotones contain opossums, marsh rabbits, cottontails, raccoons, mink, and deer. Early successional stages provide habitat for least shrews, eastern moles, cottontails, eastern harvest mice, hispid cotton rats, meadow voles, feral house cats, and deer.

The NHWEP is critical to the survival of several species associated with woodland habitats since extensive forests are a rare commodity along the Outer Banks. Eastern moles, gray squirrels, raccoons, white-tailed deer, and bats thrive in these forested communities, and although these mammals disperse from one woodland to another through less-than-optimal habitats, it is the woodlands that support the highest densities of these species. Gene flow among these isolated populations is reduced, for example between the deer herds at NHW and Buxton Woods, a distance of approximately 80 km and across Oregon Inlet. Obviously some species are more vagile (bats and larger mammals) or eurytopic (raccoons and eastern moles), and therefore less likely to suffer from inbreeding and the associated loss in genetic vigor. However, those species that are less vagile (southeastern and southern short-tailed shrews) or stenotopic (gray squirrels and eastern harvest mice) and are limited to small segments of suitable habitat can be expected to suffer from lack of gene flow. Also, hunting and trapping pressures can reduce populations to levels too low for the survival of that species, as has happened with the white-tailed deer on Shackleford Banks (Webster 1987, unpubl. ms.) and the eastern wood rat on Bald Head Island (Parnell and Adams 1970, unpubl. ms.).

CONCLUSIONS AND RECOMMENDATIONS

The mammalian fauna of NHWEP is extremely diverse and consists of 20 native and four introduced or feral species. This diversity results from a mosaic of habitat types, which provide for species variously adapted to a marsh, woodland, grassland, or ecotonal existence. By protecting and maintaining a wide array of habitats, this diversity can be perpetuated. A loss in genetic fitness in sylvan-adapted species is predicted if isolated woodland habitats are reduced or destroyed, as such action could cause the eventual extirpation of several species from the Outer Banks.

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ENVIRONMENTAL EDUCATION

ETHICS AND ENVIRONMENTAL EDUCATION

The area of environmental ethics is receiving increasing attention among many ecologists and philosophers. While many scientists are busily trying to understand the impacts of human activities on the environment, there is a growing number of individuals who are attempting to understand how humans view their relationship with the environment.

Over 40 yr ago Aldo Leopold noticed the impact of human activities on the natural world and wrote, "The usual answer to this dilemma is 'more conservation education.' No one will debate this, but is it certain that only the *volume* of education needs stepping up? Is something lacking in the *content* as well?" Leopold called for a land ethic. He recognized that we must attack the environmental crisis on two fronts if we are to solve the problems that we face. Addressing specific issues such as acid rain, water pollution, toxic waste disposal, and soil erosion, to name but a few, is certainly necessary, but not nearly enough. These issues are only symptoms of a much deeper problem, that of human attitudes toward the environment.

Discussions of the relationship between humans and the environment can be readily incorporated into existing courses such as ecology, natural history, field biology, and general biology, or offered in a separate course. During this past January interim (Erskine College has 4-1-4 academic calendar), I offered a course entitled Human Attitudes and Environmental Issues. There were no prerequisites because I wanted the course to be available to all students, regardless of academic background. The course began with an introduction to general concepts of ecology, including principles such as adaptation, population growth and carrying capacity, components of ecological communities, trophic pyramids, and biogeochemical cycles. Next we addressed individual topics of environmental concern such as nuclear winter, toxic wastes, air pollution, acid rain, water resource use, human population growth and food resources, energy use and conservation, and the history and present state of the environmental movement. I assigned readings from *Audubon, the Amicus Journal, National Geographic,* the Worldwatch paper series, and other sources suitable for a general audience. Throughout the entire range of discussions, it was often mentioned that people seem to care very little about the environment.

This brought us to the subject of environmental ethics. We discussed Aldo Leopold's *A Sand County Almanac,* Vincent Rossi's "The Eleventh Commandment: toward an ethic of ecology," and other related articles. These rather different approaches came to essentially the same conclusion: humans must learn to respect the rights of the land. Further discussions included wilderness preservation, species preservation, economics and ecology, and consideration of what steps can be taken toward a sustainable society. Discussions of ecology and economics were particularly stimulating, as we tried to balance the realities of a cost-benefit oriented society with a need to respect environmental integrity and ecological diversity. Many of the readings were taken from *People, penguins, and plastic trees: basic issues in environmental ethics,* a collection of essays edited by Donald VanDeVeer and Christine Pierce. Again, articles from *Audubon, the Amicus Journal,* the Worldwatch paper series, and the *Nature Conservancy Magazine* were good supplements. On our last day, we discussed how our daily activities, as small as they may seem, can have an impact on the environment. Every time we turn on a light, start a car, or use a paper napkin, we are having some small impact on the resource base. Although these things are so small that they seem insignificant, it is important that each of us recognizes our individual impacts on the environment. G. Tyler Miller, Jr., in *Living in the Environment,* wrote "We have all been working toward our own destruction by drilling holes in the bottom of the boat. Arguing over who is drilling the biggest hole only diverts us from working together to keep the boat from sinking."

My intent in offering this course was to draw attention to these complex issues and to show that there are moral and ethical questions to be asked when discussing environmental issues. Passing more laws, enforcing more regulations, and cleaning up pollution merely address the proximate problem of what we do to the environment, but not the ultimate problem of how we think about the environment. Too often society reinforces the concept of a separation of humans and the natural world. Many of us are so far removed from nature by countless middlemen that it's easy to see how we may lose contact with the environment. We often hear of humans against nature, not humans as a part of nature. "In short," wrote Leopold, "a land ethic changes the role of *Homo sapiens* from conqueror of the land-community to plain member and citizen of it." Several current environmental science textbooks include sections on environmental ethics. At least one recent ecology textbook (*The Science of Ecology*, by R. Brewer) discusses the subject briefly. An entire journal (*Environmental Ethics*) is dedicated to philosophical discussions of environmental issues.

The mixing of some philosophy into biology courses can stimulate student interest and discussion. Discussions of environmental ethics can lead to a better understanding of human attitudes toward the environment. Perhaps addressing environmental issues from an ethical perspective will affect the attitudes of some of the students in your classes. It is important, however, that we reach all students, not just biology majors. The scientific community will not be able to solve our environmental problems without the political support of a large number of concerned and informed citizens.

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INFORMATION NEEDS

"*Prey Information on Florida's Coastal Wading and Fish-eating Birds is Needed* for a study on the potential impact of mosquito larvicides on nontarget organisms. Please forward any relevant reprints, documented field observations or bibliographies to Jeff Lincer, Southwest Florida Coastal Research Center, Mote Marine Laboratory, 1600 City Island Park, Sarasota, Florida 34236 (813) 388-4441."

REVIEWS

Miller, G. Tyler, Jr. 1988. **Living in the Environment, 5th Ed.** Wadsworth Publishing Company, Belmont, CA. 669 p.

G. Tyler Miller's fifth edition of *Living in the Environment* is full of valuable information and extremely readable and a fine introduction to environmental sciences. The book is divided into six main sections. The first two chapters include an overview of human population growth and its effect on natural resources, a discussion of the development of human societies, and a brief history of resource exploitation, conservation and environmental protection in the United States. This general introduction focuses the reader's attention on current environmental issues and shows the importance of studying environmental science. The second main section introduces and explains fundamental physical and chemical principles and provides a good introduction to basic ecology. The level of coverage is suitable for students with little background in the sciences. After these first two sections, the rest of the book could be covered in any order suitable for the course being taught. The remaining four sections provide detailed discussion of the general topics of population, resources, pollution, and environment and society. This last section provides a practical discussion of the relationship between environmental issues and economic and political factors, as well as a good introduction to environmental ethics.

The 26 chapters are all generously supplied with photographs and colorful illustrations to supplement and summarize major points in the text. Each chapter begins with a list of objectives and ends with a summary. Many chapters contain "Spotlight" inserts which focus on specific, sometimes controversial topics relevant to the chapter. Here are just a few examples: Should government funds be used to aid family planning in the United States?; The snail darter controversy; Should grazing fees on public rangeland be increased?; A setback for the Rhine River; The Chesapeake Bay, an estuary in trouble; The Love Canal tragedy; Should scrubbers be required on all U.S. coal-burning power plants? There are many others, and they are all effective in focusing broad concepts on current issues. In addition, many provide good topics for class discussions. Similar to the "Spotlights," but providing greater detail, are 10 "Enrichment Studies" that precede the summary in some chapters. These include discussions of desertification, risk analysis and risk management, the Great Lakes, and home contamination by radon gas. There are also 14 "Guest Essays" in which different authors offer opinions on topics such as "Nuclear war: the worst environmental threat," "Becoming a deep ecologist," and "Nuclear power: a Faustian bargain we should accept." Miller is to be commended for balancing his treatment of many controversial issues by explaining different sides of many arguments and including some essays that argue against his own point of view.

Those of you familiar with earlier editions of this text will find several improvements. The figures are now in color, making them more attractive and easier to interpret, and the number of figures has more than doubled. Enrichment studies are now presented at the end of each chapter, instead of at the end of the book. This makes them more an integral part of the book, rather than supplementary reading. Several of the enrichment studies from the fourth edition have been expanded into full chapters, and new enrichment studies have been added. There are seven new guest essays. The "Spotlights" are new and valuable additions. A Student Preface has been added to introduce students to the author's background and the overall organization and goals of the book.

Besides being a good general textbook, *Living in the Environment* also provides practical information that makes the book worth keeping. Information on how to save water and money, alternatives for some hazardous household chemicals, major safety features of U.S. nuclear power plants, and an essay on how to influence elected officials are just a few examples. In addition, Appendix 1 is an extensive list, including addresses, of environmentally oriented periodicals, organizations, and federal and international agencies. The text also includes an updated list of readings organized by chapter topics.

No book is perfect, and a few small glitches do appear in this one. These are minor points, however, such as referring to the snail darter as a "minnow." (The snail darter is a small member of the perch family, Percidae, whereas minnows are in the family Cyprinidae.) Such errors may distract those who notice them but they do not detract from the value of the discussion being presented.

Living in the Environment is a well-organized and complete general introduction to human ecology and environmental sciences. I'm looking forward to using it in my Environmental Science course this coming year and seeing how it is received by the students.

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Miller, G. Tyler. 1988. **Environmental Science, 2nd Ed.** Wadsworth Publishing Co., Belmont, CA. $33.75. 407 p.

It is impossible to review *Environmental Science* (herein, ES) without a comparison to the fifth edition of *Living in the Environment* (herein, LE—basic text of 603 pages; $43.25), since it is a briefer version of this well-known text. It should be clearly pointed out that ES is not a "watered-down" version of the larger text, rather it contains the basic information with most of the figures, tables, etc., unchanged.

Both books are essentially the same in the treatment of the human population, matter and energy concepts, ecosystems, biotic and abiotic resources, pollution, waste, and pest control. ES includes a good chapter on risk-benefit and cost-benefit that is not included as such in LE.

Miller states in the "Preface: To the Instructor" of ES that the book has less emphasis on environmental economics, politics, and ethics–and so it does. The 14 Guest Essays and 10 Enrichment Studies of LE, as well as Chapter 23, "The Environment and Human Health: Disease, Food Additives, and Noise," and Part Six, "Environment and Society" (Chapters 24–26), are excluded from ES. In my opinion, he has left out most of the really good stuff. I have used LE for several years now with many different classes, both majors and non-majors. Although it is tedious to read, with facts and figures following facts and figures, these are relieved by the more interesting (to students) digressions into differing viewpoints, applications, etc., missing from ES.

LE allowed me to sneak in several extras that I could not include as easily if I were to use ES, e.g. the Enrichment Study, "How to Influence Elected Officials" is very helpful when requiring students to write letters concerning environmental issues. Also, a lot of geography can be included because a number of world maps are used in LE. These are missing from ES. There are other examples but these would vary greatly from instructor to instructor.

There is a positive aspect to ES that would probably be overlooked unless one had taught from LE. I refer to the colors, a combination of muddied earth tones, used for the tables, figures, spotlights, etc. in LE. These were often difficult to distinguish, e.g. see Figures 16–17, and my students thought they looked awful! They would most likely think that the combination of ochre-khaki-tan of ES looks awful too; however, these colors are, I think, easier on the eyes. Mercifully, the fading-color effect of the highlighted sections is missing from ES.

I have not seen the supplementary materials for ES, referred to in the flyer as "A Comprehensive Teaching Package including Instructor's Manual, Micro-pac: The Wadsworth Testing Service, and set of 150 transparency Masters." I understand that the transparencies are the same as those given with LE, which are selected figures from the text. An Instructor's Manual and a Study Guide are also available with LE.

Miller's books are purported to be the most widely used environmental texts in the country. I can understand why, since I've switched from time to time and have always come back. The information is there. One can choose to leave out great chunks of material and still have a wealth of topics to consider. Miller sticks to an objective presentation, in the main body of text material, perhaps trying too hard at times to cover all the bases. Simply put, if one wishes to have the "facts," ES will suffice; however, if one wishes to have a wider view, LE must be the choice.

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Eaton, John C. 1988. **Lepidopteran Anatomy.** Wiley-Interscience Series in Insect Morphology. John Wiley and Sons, NY. $49.95. 257 pp.

The title *Lepidopteran Anatomy* suggests a broad coverage of the anatomical diversity among members of the order Lepidoptera. In fact, except for 26 pages, the volume is devoted entirely to the tobacco hornworm, *Manduca sexta* (Linnaeus) (Sphingidae).

A brief account of the egg of *M. sexta* (Chapter 1) is followed by chapters on: the exoskeleton and muscles of the larva (2) and adult (4); external features of the pupa (3); nervous system and endocrine glands (5); circulatory (6) and respiratory systems (7); alimentary canal, salivary glands, and excretory system (8); and internal reproductive organs (9). The final two chapters, which are more diverse with respect to the organisms used as examples, deal with exocrine glands (10) and sound production and recepton (11). Also appended are a brief section on anatomical methods, a list of abbreviations, and an index (which lacks many terms given in the list of abbreviations).

Although well-written, the book falls short as a single-source reference on the anatomy of the Lepidoptera. Besides giving credence to the book's title, the addition of a discussion of the major anatomical differences among the larvae, pupae, and adults of the five suborders of Lepidoptera is likely to have assured a more widespread and frequent usage of the work.

Of foremost importance in publications of this kind are the illustrations. Eaton provides a generous number, 192, all of which are sufficiently large and appropriately oriented to serve their users well. While many figures are clear and well executed, some, including those redrawn from other works, appear to have been hastily prepared. Most have some or all of the included abbreviations explained in the captions—a practice for which the author is to be commended. Although for the most part the labeling appears to be accurate, we noted the following errors: Fig. 2.5, ST (sternum) should be STE (stemmata), Figs. 2.15, 2.16, SPI (spine) should be SPE (spinneret); Figs. 4.5, 4.6, PE (phallus extensor muscle) should be PED (pedicel); Fig. 4.34 (caption), R (radius) should be RT (rectum); Fig. 5.19, ED (exit duct) should be EJD (ejaculatory duct); Fig. 9.5, AG (anterior midgut) should be AGL (accessory gland); Fig. 9.5 (caption), BC (buccal cavity) should be BCO (bursae copulatix); Fig. 9.6 (figure), SEO [sic] should be SED (seminal duct).

To facilitate comparative studies, this book, and future parts in the series, would benefit from a close adherence to an established, consistent terminology, a summary of new material presented, and a fuller documentation of earlier contributions. Each chapter lists from 1 to 31 selected references; however, no references are cited in the text except in Chapters 10 and 11. While this omission makes the book quite readable, only those already knowledgeable in this area will recognize new information and new anatomical terms. In some instances, Eaton's terminology seems to depart from classic texts as well as specialized works on the Lepidoptera, with no explanation or justification. For example, Hodges (1971) published a definitive study on the North American sphingids with illustrations of the wing venation labeled in accordance with the thinking of most North American lepidopterists. In Eaton's Figs. 4.20 and 4.21, however, the radial sector (Rs) of Hodges (and many other entomologists) is labeled R_2, and there are further discrepancies in the labeling of the anal veins between Eaton and various lepidopterists. Similarly, Eaton's designations for thoracic muscles do not correspond to any of five nomenclatural systems tabulated for the Lepidoptera in Matsuda (1970). One must refer to Eaton's earlier papers for the derivation of his terminology and a discussion of homologous terms used by other workers.

Among the questionable or erroneous statements in the text are the following: in reference to the tobacco hornworm adult, it is stated, p. 73, that "Males are 48 mm long and females 52 mm long," (as if there is no range in size within the species) and, p. 88, that the metathoracic wings have the same venation in males and females "except three anal veins in females," (we note only two in both sexes; indeed this feature is used in family level keys); p. 212, "*Utethesia* [sic]" should be *Utetheisa*; p. 216, "*Dacychiva* [sic] *pudibunda* (Dyar)[sic]" [=*Dacychira pudibunda* Linnaeus], should be *Calliteara pudibunda* (Linnaeus), the presently accepted name; p. 222, "*Vitula edmandsae* [sic] Ragnot [sic]," "*Archips agryospilus* [sic] Walker [sic]," "*A. rosanus* [sic] (L.)," and "*A. corasivoranus* [sic] Fitch [sic]," should be *Vitula edmandsii* (Packard), *Archips argyrospila* (Walker), *A. rosana* (Linnaeus), and *A. cerasivorana* (Fitch); p. 235, "*Spectrum lineata* (F.)" or "*Spectrum* (*Celerio*) *lineata*," should be *Hyles lineata* (Fabricius), the presently accepted name.

Imperfections aside, this lucid book provides an in-depth anatomical guide to the larva and adult of the tobacco hornworm. It should prove useful to biologists, particularly anatomists, physiologists, and others who work with this intriguing organism.

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Matsuda, R. 1970. Morphology and Evolution of the Insect Thorax. Mem. Entomol. Soc. Canada 76. 431 p.

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Raven, Peter H., Ray F. Evert, and Susan E. Eichhorn. 1986. **Biology of Plants, 4th ed.** Worth Publishers Inc., NY. 775 pp.

This textbook is an informed, ambitious, and visually attractive presentation of botanical science. The 32 chapters are arranged in nine sections that develop a comprehensive, yet manageable, treatment of plants in an evolutionary-ecological context. The sectional organization affords flexibility in use, permitting selective topical emphasis without compromising the integrity of the presentation.

A synoptic evolutionary history of plants in the initial chapter is followed by a description of the organization of the plant cell in Section 1 (Chapters 2–4). Energy flow in the plant cell is traced in Section 2 (Chapters 5–7). Eukaryotic genetics in Section 3 (Chapters 8–9) provide a smooth transition to the expansive consideration of organismal diversity in Section 4 (Chapters 10–18), the longest unit of the book. The discussion in Chapter 10 of the probable evolutionary affinities of the five kingdoms is thought-provoking. Evidences from both the fossil record and comparative morphology and physiology, which are presented in subsequent chapters of this section, argue convincingly for these putative relationships. The dynamics of the angiosperm plant—development, growth, nutrition, and transport—are presented in Sections 5, 6, and 7 (Chapters 19–27). The unifying themes of the text, evolution and ecology, are addressed expressly in Section 8 (Chapters 28–30) and Section 9 (Chapters 31–32).

This book is a rewarding experience for the conscientious student of botany, and is a reliable reference volume in plant science. The authors communicate a wealth of information in a polished and precise style. A salient feature of this book is the immediate treatment of botany. Topics such as basic chemistry, monotonously predictable in the early chapters of most botanical texts, are deferred to convenient appendices. This text is most appropriate for undergraduate students with previous experience in college-level courses, including introductory biology. A measure of sophisticated reading skill and an above-average vocabulary are expected of the reader. This is the most attractive of current introductory botanical texts; however, its adoption should be evaluated in the context of student capacity to manage the challenge that it presents.

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NEWS OF BIOLOGY IN THE SOUTHEAST

Jon R. Fortman—*News Editor*
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ABOUT PEOPLE AND PLACES

Alabama

Tuskegee University, Department of Biology. The 15th Annual Student Research Symposium was held in March, sponsored by the Sigma Xi Chapter, Minority Biomedical Research Support, and the Minority Access to Research Careers. The speaker was *Dr. Clement L. Markert,* University Research Professor, School of Agriculture and Life Sciences, North Carolina State University. The following award was made at the 14th Initiation and Awards Banquet of Sigma Xi: *Dr. Adriane G. Ludwick* was awarded the second *Russell W. Brown* Distinguished Scientist Research Award for 1988. Other awards were presented to students for posters and papers delivered at the Annual Symposium. *Dr. J. H. M. Henderson* was one of 34 botanists who attended China sponsored by the People to People Citizens Ambassador Program.

Florida

Florida State University, Department of Biological Science. Sharon Y. Strauss (Ph.D. student) was the 1988 recipient of the *Margaret Y. Menzel* Award. This award recognizes outstanding achievement by an advanced graduate student. She was also awarded the *Murray F. Buell* Award for Excellence in Ecology from the Ecological Society of America. The award recognizes the best paper presented by a student at the ESA's annual meeting and includes a $100 certificate. Her paper was "Historical effects of herbivory on sumac fitness." *Water A. Tschinkel,* Professor, was elected as secretary of the Florida Department of Agriculture and Consumer Services, Pesticide Review Council. *E. Imre Friedmann,* Professor, was conferred the title of concurrent professor by Nanjing University, People's Republic of China, and will be teaching at the University periodically. *Lawrence G. Abele,* Professor, was elected to the rank of Fellow of the American Association for the AAAS. *Dexter A. Easton,* University Service Professor, presented a paper on Gompertz kinetics of the Na+ channel to the Mathematical Research Branch at NIH, an invited seminar. *John A. Elam* (Professor) and *David A. Balkwill* (Associate Professor) were awarded the 1988 President's Teaching Award for excellence in undergraduate teaching. *George A. Bates,* Associate Professor, was awarded the 1988 Developing Scholar Award.

University of South Florida, Department of Biology. Dr. Mary Jane Saunders, Assistant Professor of Biology, has recently been awarded a grant from NSF for $140,000 to study "Calcium Regulation of Cytokinin Stimulation Morphogenesis in Plant Cells." *Dr. Glen Woolfenden,* Professor of Biology and a Director of the Cooper Ornithological Society, presented a paper entitled "Viable populations of the Florida Scrub Jay for Conservation" at the annual meeting, Asilomer, California, 16–22 March 1988.

Rollins College, Department of Biology. Dr. Stephen W. Klemann, Asssociate Professor of Biology, will be spending 1988–89 in the laboratory of *Dr. R. Michael Roberts* of the Animal Sciences Research Center of the University of Missouri–Columbia. During his sabbatical, *Dr. Klemann* will be working on various projects associated with mammalian developmental and reproductive biology.

Archbold Biological Station, Lake Placid. Probably the most significant single addition to the physical plant in the Station's 47-year history was the completion of a 3,500 sq. ft. building. It is connected to the Main Building and houses a lecture hall, offices and laboratories, as well as rooms used for the herbarium, animal collections and conferences. The real baptism of the building occurred in February 1988 when *Dr. Ernst Mayr,* Agassiz Professor Emeritus of the Museum of Comparative Zoology, Harvard University, presented a lecture to some 100 scientists. *Dr. Eric S. Menges* joined the staff as a Research Biologist in Plant Ecology. He was formerly associated with the Holcomb Research Institute at Butler University. *Shirley R. Denton,* Archbold Research Fellow, left ABS to become a Senior Ecologist at the Biological Research Associates in Tampa. Current Research Associates (non-salaried members of the Station's Scientific Staff that conduct continuing research at the Station) are: *Warren G. Abrahamson, David Burpee*, Professor of Plant Genetics at Bucknell University, *Thomas Eisner, Jacob Gould Schurman*, Professor of Biology at Cornell University, *Ronald L. Myers*, Director, Fire Management and Research Program, The Nature Conservancy Southeast Region, *Glen E. Woolfenden*, Distinguished Professor of Biology, University of South Florida. *James T. Cronin, Noreen Gallo* and *Nancy G. Stotz*, Research Assistants, have left the Station to pursue graduate studies or new positions.

Kentucky

Western Kentucky University, Department of Biology. Dr. Herb Shadowen retired from the department after 26 years of teaching and research in zoology, ornithology, mammology and entomology. He joined the faculty in 1962 following a position at Louisiana Tech. New positions include: *Dr. Kenneth Balak* (Ph.D. University of South Carolina, Genetics) in developmental biology. He did postdoctoral work at Baylor College of Medicine, the University of Utah and the Bekesy Laboratory of Neurobiology at the University of Hawaii, and *Dr. Claire Rinehart* (Ph.D. University of Georgia, Botany), with postdoctoral work at the Institute for Molecular Virology at the University of Wisconsin. *Dr. Blaine Ferrell* was awarded $28,000 for two years by NIH to continue his work on circadian changes in the ommatidia of cockroach. *Dr. Larry Gleason* received an NIH grant of $68,000 for research over a two year period on defense reactions of Amphipods to Acanthocephla.

Mississippi

Mississippi University for Women, Division of Science and Math. Dr. James Strobel, President of the University and Professor of Biology, has resigned to take a Distinguished Professorship at Jackson State University.

University of Mississippi, Biology Department. Dr. Wilbrod St. Amand and *Mrs. Georgia St. Amand* retired 4 May after a combined 60 years with the department. *Dr. W. David Dawson* will assume the position of Assistant Professor. He will teach introductory mammalian physiology, anatomy and physiology and general biology. *Dr. Gary Miller* is a new Assistant Professor in the department and will teach general ecology, fish biology, and general biology. *Dr. Al Mikell* received a grant from Eastman Kodak for $26,000 to investigate commercial utilization of isolates of microorganisms with ice nucleation and antifreeze activity. *Dr. Iola T. McClurkin*, Interim Chairman of the department, has been advised that the AAUW Education Foundation has appointed her as a member of the American Fellowships Awards Panel for 1988–90. This panel is responsible for evaluating fellowship applications and for ranking and recommending selections for funding.

Gulf Coast Research Laboratory, Ocean Springs. Dr. Sharon Walker has been hired to fill the newly created position as Coordinator of Marine Educational Programs at the J. L. Scott Marine Education Center in Biloxi. *Dr. Walker* received her doctorate from the University of Southern Mississippi and was a former science teacher in the Pascagoula public school systems. She also was a chemist at GCRL and in private industry. She was honored in 1983 as the state's Outstanding Secondary Science Teacher.

North Carolina

Wake Forest University, Department of Biology. The department has received an $800,000 grant from the Howard Hughes Medical Institute's Undergraduate Biological Sciences Education Initiative. The funds will be used to strengthen all aspects of the undergraduate offerings, particularly undergraduate participation in research. The department has also received two grants totaling $196,588 for "Biological Instrumentation Development: Video-based Computer Assisted Image Analysis." NSF provided $120,000 and the remaining $76,588 was granted by the North Carolina Biotechnology Center. The program will be administered by *Drs. Nina Allen* and *M. J. Jaffe*. Three new faculty have joined the department. *Dr. William Conner* (Ph.D. Cornell), an insect biologist specializing in chemical ecology, came from the Duke University faculty. *Dr. Ellen Sims'* (Ph.D. Duke, Botany) research interest is plant genetic components of plant-herbivore interactions. She has four years of post-doctoral experience at Duke University. *Dr. James F. Curran* (Ph.D. Rice University) is a molecular biologist and examines the structural requirements of transfer RNA function. He completed three years of post-doctoral work at the University of Colorado.

South Carolina

Furman University, Department of Biology. Two department members retired this past year: *Dr. C. Leland Rodgers* (Botany) and *Dr. Robert W. Kelly* (Invertebrate Zoology). New faculty are *Dr. Edward Otto* (Genetics), *Dr. Joseph Pollard* (Botany, Ecology), *Wade Worthen* (Ecology).

Savannah River Ecology Laboratory, Aiken. Dr. Gary K. Meffe has been elected to the board of editors for *Conservation Biology. Dr. Justin D. Congdon* has been elected to the board of editors of the *Journal of Herpetology. Paul L. Leberg,* a University of Georgia graduate student conducting his research at the Laboratory, has received the 1988 *A. Brazier Howell* Award by the American Society of Mammalogy for his paper titled "Heterozygosity and the growth of deer fetuses: a test of the overdominance hypothesis."

Tennessee

Belmont College, Department of Biology. Dr. Billie R. Lang, a cell biologist, recently joined the faculty as an Associate Professor.

East Tennessee State University, Department of Biological Sciences. Dr. Robert Samuels, former chairman and Professor, retired. He has been granted professor emeritus status and will continue research in carbohydrate metabolism in trichornonad flagellates. *Dr. John D. Moore,* Professor, retired in May after 25 years at the University. *Dr. Hugh A. Miller, III,* has been appointed as Assistant Professor in Molecular Biology and Protein Biochemistry. *Dr. Miller* has a Ph.D. from the University of Tennessee, Knoxville and currently is a postdoctoral fellow in the Department of Anatomy and Cell Biology at the Medical University of South Carolina at Charleston.

Memphis State University, Department of Biology. Dr. S. Edward Stevens, Jr., will fill the Chair of Excellence for Molecular Biology. He received his Ph.D. from the University of Texas and is presently director of the Co-operative Program in Biotechnology at Pennsylvania State University. His research interests involve the regulation of metabolism in photoautotrophs with emphasis on the cyanobacteria. *Dr. Beverly Collins,* a plant ecologist, is coming to the department from the Savannah River Ecology Lab. Her Ph.D. is from Rutgers, and her primary research interest deals with the mechanisms of species co-existence and turnover, role of disturbance in determining environmental change and plant population dynamics. *Dr. Charles Lessman,* an animal physiologist, comes from the University of Iowa. His Ph.D. is from the University of Minnesota, St. Paul, and his research centers on the experimental investigation of regulatory mechanisms in ovarian function.

Virginia

The James Madison University, Department of Biology. Two grants have been received to study the genetics of the poly-beta-hydroxybutyrate pathway in bacteria. The first one from NIH is for $54,000 and the second grant from NSF amounts to $86,000. The goal of the projects is to analyze the mode of PHB-specific transcriptional regulation employed during times of environmental stress. Both grants are under the direction of *Dr. Douglas Dennis.*

West Virginia

Fairmont State College, Department of Biology. Dr. Steve Stephenson, Professor of Biology, is this year's recipient of the *William A. Boram* Award for Teaching Excellence. This award is given each year to the one individual selected as the college's most outstanding teacher.

ABOUT MUSEUMS AND BOTANICAL GARDENS

Kentucky

Museum of History and Science, Louisville, Dr. William Sudduth, president of the Museum, announced today that institution's receipt of a $75,000 Institute for Museum Services grant. According to information released by the director of IMS, the museum was the sole recipient of the funds in the state of Kentucky. The grant, awarded on the basis of application and institution quality, is to be used for operating expenses.

Mississippi

The Crosby Arboretum, Picayune. A new slate of officers was nominated and elected at the annual meeting of the Arboretum Foundation. The officers are: *Michelle Heidelberg,* president; *Anne Bradburn,* vice-president; *Howell Crosby,* secretary; and *Lida Rogers,* treasurer. Newly elected board members are: *William P. Conery, III, Gail Criss, E. Howell Crosby, Mary Hough,* and *Phineas Stevens. Courtney Blossman* was re-elected to a second three-year term on the board. New advisory board members include Senator *Thad Cochran, L. Osmond Crosby, Dr. Richard Harris* and *Bill Thames. Lynn Crosby Gammill,* outgoing president, will become chairman of the board.

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